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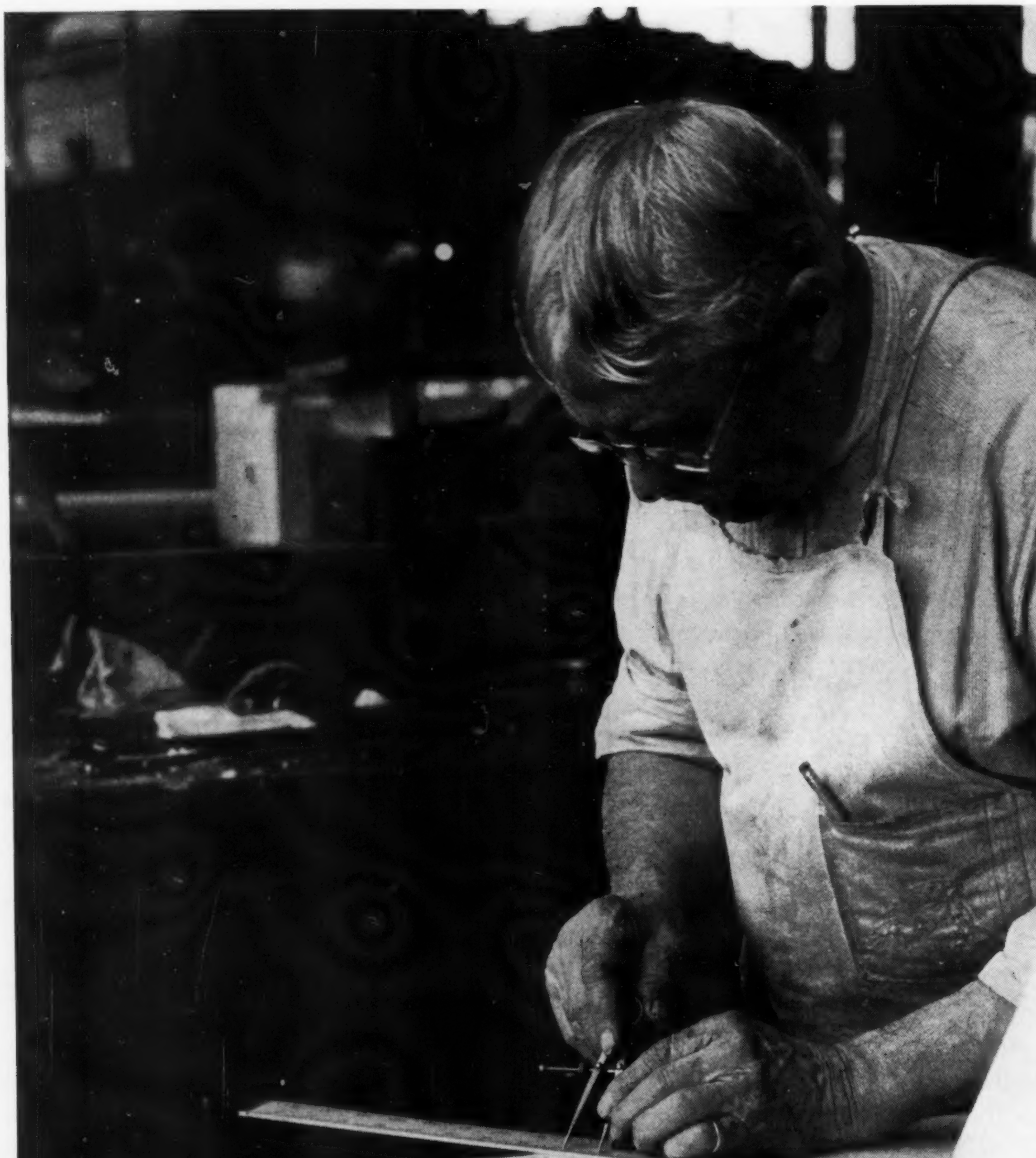
Nesmith

The Pattern Maker

Volume 61
No. 6

MECHANICAL ENGINEERING

June
1939

GEORGE A. STETSON, *Editor*

Covers

IN CASE you haven't already guessed it, this month's cover shows (so we have been told) a portion of the City of San Francisco with the Bay in the background. Some time ago, just before one of the Society's national meetings, an enterprising local publicity committee sent in a cover picture that was distinctive and typified the convention city. It was used. The idea caught on and hosts of the Society in other cities provided pictures to be used in connection with later meetings. This month it is San Francisco's turn because the A.S.M.E. 1939 Semi-Annual Meeting will be held in that city in July.

Choosing cover pictures has its hazards and its techniques, but identifying them calls for courage and sure knowledge. Most readers expect a cover picture to be identified, but the humiliating truth is that many pictures can't be identified; not even the photographer knows, in many cases, what he has photographed, and usually when he thinks he does know he is wrong or his facts are incomplete. We have learned from experience that it is better not to identify a picture than to err in attempting to identify it. But when the picture can be identified, identification appears at the head of the table of contents.

Spectrographic Analysis

LIKE many other scientific instruments, the spectrograph is rapidly becoming a familiar working tool in industry. Its use is no longer confined to astrophysicists and physical chemists; ordinary technicians manipulate it with satisfactory results in daily routine analyses; and its versatility is becoming well established. To these facts competent and abundant testimony is to be found in an informative booklet, "Spectrographic Analysis in Great Britain," recently published by Adam Hilger, Ltd., London.

The 28 brief articles that make up the booklet are arranged under four main heads in accordance with the principal uses to which the spectrograph is applied in routine work: metallurgy; glasses, paints, and fabrics; soils and plants; and art, archaeology, and crime detection. Industrial uses center chiefly in the first two of these classes. The positions held by the writers of the 28 articles leave no doubt as to the authority of their testimony as to the value of the spectrographic technique.

Spectrographic analysis is resorted to, as the articles themselves reveal, for the quantitative and qualitative determination of the presence of metals in materials. Three main reasons are given for using spectrographic in preference to alternative methods of analysis. First, in routine control it is said to be quicker and to require fewer workers. Second, in estimating small traces of certain elements it may be more reliable than chemical analysis. Third, it can be used on very small quantities of material. These are compelling reasons and explain why, as one comment testifies, its use in one industrial laboratory has increased from 200 samples analyzed per month to 2500, and is still growing. At this laboratory the following applications of spectrographic analysis are made: The checking of the purity of all virgin metals; the examination of castings and semi-finished products for impurities or added constituents, the examination of samples for matching, the examination of defects, possibly due to segregation, and the examination of precipitates, corrosion products, fluxes, paint pigments, water residues, and soils.

As to the rapidity with which spectrographic analyses can be made another contributor writes: "The complete analysis of twelve samples of cartridge brass will occupy one analyst about a week, whereas they can be analyzed quantitatively by spectrographic methods within three hours."

In an increasing number of industrial laboratories in this country the spectrograph is to be found. In fact, in the words of one of the British contributors to the pamphlet referred to, "no laboratory could be fully equipped without one." Thus does science come closer to the workshop.

Patent Data Wanted Promptly

MECHANICAL engineers have about as great a stake as any group in the proper functioning of the patent system. Some are affected directly, others indirectly, by any proposals to modify the system. All should be alert to see that only intelligent action is taken by the Congress, and all should be concerned with a proper understanding on the part of the Congress and the public of the highly technical and somewhat confusing problems that are involved. Prejudiced and uninformed opinions, and impractical visionary attempts to introduce changes and so-called reforms should be combatted. Sincere attempts on the part of responsible persons to introduce changes for the benefit of the nation as a whole should meet with equally sincere responses by engineers and inventors with a view to advancing intelligent discussion and action and avoiding modifica-

tions that, in the long run, would work out to the advantage of neither the public nor the special interests of those whom the patent system is intended to protect.

With the object of securing reliable information on many of the issues involved in the patent situation, the American Engineering Council, in conjunction with the National Association of Manufacturers and the National Industrial Conference Board, is making a study under the direction of an A.S.M.E. member, Fairfield E. Raymond. A statement of the study and a questionnaire designed to bring to light pertinent facts relating to patents and the operation of the patent system will be found on pages 483–484 of this issue. Engineers and inventors are strongly urged to cooperate by providing the information requested as an aid to this important study. Prompt action is imperative.

Jobs for Engineers

ON ANOTHER page of this issue a correspondent calls attention once more to the potential market for engineering services that exists in thousands of small plants and industries that normally have no engineering departments and no employees with engineering training and methods of work.

An alert person, looking about him at what has happened in cases where engineering has been applied to plants and industries, and in trade, commerce, and business generally, to say nothing of agriculture, is likely to be convinced that the process of applying engineering knowledge and methods of work is rapidly spreading over all areas of our social and economic life, even though the greatest amount of attention is given to sectors of it that developed originally from science and engineering. The problem is to accelerate this broadening application of engineering. Engineers have a stake in it because of the potential market for their services. The nonengineered plants and industries have a stake in it because of the possibility of more profitable operation in an era of increasing competition.

Engineers and others would make greater progress with this problem if they better understood what engineering is. There are many good definitions of engineering, but for the present purpose one devised by Gano Dunn serves best. "Engineering," declares Mr. Dunn, "is the art of the economic application of science to social purposes." Pondering this definition one realizes how broad engineering is and how narrowly it is conceived by many who profess to practice it. And perhaps here is one reason why engineering has not made greater progress in many small plants and industries. Neither proprietors nor engineers recognize that engineering can be applied to the enterprise.

It is probably true that most teachers of engineering students hold this broad view of engineering and attempt to preach it on all occasions. Probably a majority of engineering students also comprehend what is meant and conceive of engineering in this broad sense. But the same cannot be said for a majority of laymen, who remain to be taught and convinced, nor is it true that because engineers hold this broad view they can all practice engineering in this broad sense. Many, who have devoted years to the practice of narrow specialties under the supervision of other men, lack the skill, even if they have the understanding, to practice it in a sterile, perhaps hostile atmosphere, under the spur of their own initiative. Perhaps one reason why there are not more opportunities is because the most competent men find employment in the industries that employ many engineers, while the qualities necessary for success in a nonengineered industry are not always possessed by the less competent.

It would be helpful if workable and inexpensive programs could be planned and put into effect by educational institutions and engineering societies with the object of extending the field of engineering practice into more small plants and nontechnical industries. Everyone stands a chance to profit, the industries, the engineering profession, the educational institutions and societies, and the engineers who would thereby find new forms of employment.

National Delegates Heeded

WHEN THE fourteen national delegates from the seven regional local-section conferences completed their labors at the national conference held last December in connection with the 1938 Annual Meeting of The American Society of Mechanical Engineers, they transmitted to the Council of the Society more than sixty suggestions, recommendations, and comments on Society affairs. The Council referred these items to the appropriate standing committees and from the reports and actions of these committees prepared a statement covering every one of the items. A summary of this statement appears on page 485 of this issue. Thus has the Council demonstrated its eagerness to heed recommendations brought to it from the members by way of the local sections, the regional conferences, and the national conference.

In days of dictatorships this example of the working out of democratic principles by an orderly and fairly efficient form of representative approach to an authoritative governing body is extremely encouraging. By the mechanism of this approach, personal and individual opinions and recommendations can receive the attention of local sections. If the local section considers the questions involved of sufficient importance, it can instruct its regional delegate to lay them before a regional conference. After discussion at the regional conference, the national delegates of that conference can be requested to bring the questions up for consideration at the national conference at New York, where decision is made as to whether they should be passed on to the Council. By this process trivial matters and those which arise from misunderstanding of policy and practice can be eliminated from the recommendations forwarded to the Council, and that body is assured that only matters that responsible representatives of the members consider to be important are passed up to it.

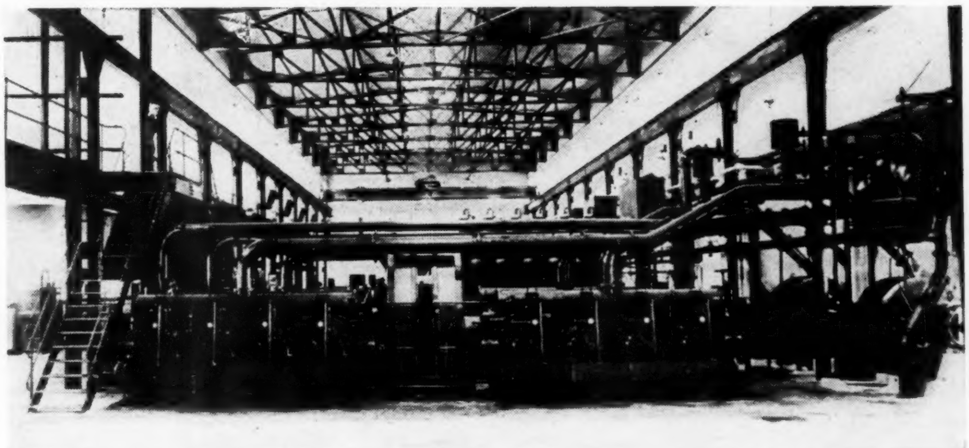

FIG. 1 HORIZONTAL 8-CRANK 16-CYLINDER 3000-BHP VIS-À-VIS OIL ENGINE DRIVING ALTERNATING-CURRENT GENERATOR

Present Position of HEAVY-OIL *and* GAS ENGINES *in* GREAT BRITAIN

By A. K. BRUCE

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IT WAS with much pleasure that the author received the invitation to submit a paper before this conference. The pleasure would have been greatly enhanced, for the author, had he been able to present the paper in person, since it was at Bridgeport, Connecticut, that he served his apprenticeship and spent some happy years. Incidentally, it was at Bridgeport that he first saw (less than forty years ago) a gasoline-engine-driven automobile. In those days—not so long ago—the standard form of private road transport for pleasure purposes was the horse and buggy, and the gasoline engine was as yet unchallenged by the compression-ignition oil engine. Whether the internal-combustion engine has or has not been a boon to mankind is not a question for the present paper. Because human nature is what it is, the tools evolved by the skill and tenacity of engineers become instruments either beneficent or harmful. It is not the fault of the tool if mankind employs it for infamous purposes. This paper does not deal, however, with aviation engines, but with the present position of the heavy-oil engine and the gas engine as manufactured in Great Britain for industrial and transportation purposes.

STATIONARY OIL ENGINES

The bulk of the medium-speed heavy-oil engines built in Great Britain during 1938 for stationary installations have been of the four-cycle vertical description with direct injection and open-type combustion chambers. In some cases—and the practice is increasing—these engines have been pressure-charged with blowers driven either by exhaust-gas turbines or by independent electric motors. Examination of the weight particulars shows that with the present standard types of medium-speed engines, direct-coupled to alternating-current generators of from 250 to 500 kw capacity, the generator output per ton of total (engine and generator) net weight ranges from 7 to 10 kw, calculated to the continuous full-load output of the generator. This output is of course much augmented by pressure charging the engines. Among tendencies in the detail design of vertical four-cycle engines have been the increasing employment of oil cooling on pistons larger than 15 in. (380 mm) in diameter, and the replacement of cast-steel bushings for connecting-rod bearings with bushings of forged mild steel. Great attention has also been paid to the development of babbitt metal giving high resistance to fatigue, and to such details as fuel injection, piston and oil scraper rings, valve springs, utilization of waste heat, and methods for insuring complete oil filtration. The importance of all factors contributing to stamina in an oil engine must receive special recognition where, as in the case of British production, so large a fraction of the output is for export to sites overseas, many of them remote.

As instancing the dependability of the oil-engine power plant installed for dealing with heavy mining loads, it has been stated by F. J. Mars that in the large powerhouse at Broken Hill, New South Wales, with a collective oil-engine capacity of approximately 27,000 bhp, there has been no interruption of the supply of electricity or compressed air in the

To be presented at the Twelfth National Oil and Gas Power Meeting of the Oil and Gas Power Division of The American Society of Mechanical Engineers to be held at Ann Arbor, Mich., June 19–22, 1939.

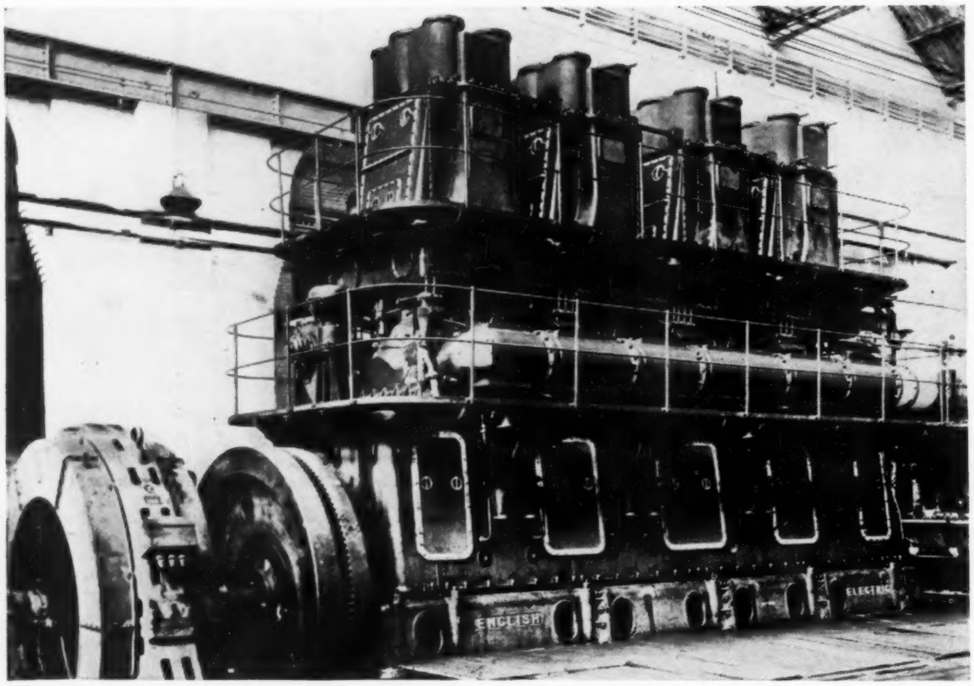


FIG. 2 TWO-CYCLE 3500-BHP OPPOSED-PISTON OIL ENGINE DRIVING ALTERNATING-CURRENT GENERATOR

period of seven years during which the station (the most important of its kind in the British Empire) has been at work. It is also on record that in this powerhouse there has been no instance of an oil-engine-driven alternator pulling out at any time, even when, due to storm or accident, the primary transmission lines at 7000 volts have been short-circuited.

It is to be noted that apart from vertical four-cycle engines, large numbers of horizontal four-cycle oil engines have been built, these including some of the most powerful stationary engines yet produced in Great Britain. Prominent examples are the two 16-cylinder vis-à-vis engines now operating at Jerusalem, each of which has a pressure-charged full-load output of 3000 bhp. See Fig. 1. These engines drive alternating-current generators which supply current for transmission to Bethlehem and other districts around Jerusalem. The horizontal oil engine, in addition to the advantage of great accessibility, is readily convertible for operation on gas. Large engines of this type are now built almost exclusively in the vis-à-vis form. The leading maker has already produced engines totaling 110,000 bhp, and their design and success owes much to the mechanical sagacity of the late John Henry Hamilton of Sandiacre who originated, fifty years ago, the positive scavenging and pressure charging of internal-combustion engines.

In mining power plants with heavily fluctuating loads, the practice of pressure charging four-cycle oil engines is increasing. With independent pressure-charging equipment, as used on the horizontal vis-à-vis engines, the air required for dealing with sudden increases in load is always available, and with suitable overlap of the valves, the pressure charging can be combined with positive scavenging. In most of the externally pressure-charged British four-cycle horizontal oil engines operating on mining loads, the net increase in continuous output given by pressure charging is from 20 to 25 per cent calculated to the normal temperature-pressure rating of the engine. This is a net increase, as the actual gross output is higher by the amount of power which, taken from the generator, is absorbed in driving the blower. The increase in output is obtained without increase in exhaust temperature. Considerable development is also shown in applications of the Büchi arrangement where the pressure-charging equipment is driven by an inbuilt exhaust-gas turbine. This tendency is becoming strongly marked on four-cycle vertical engines and has been stimulated by the onset of the two-cycle type.

In regard to large stationary two-cycle oil engines, the only type which has been manufactured to any appreciable extent in Great Britain is the opposed-piston engine, of which units aggregating rather more than 100,000 bhp are now at work or on order. The largest stationary oil engine yet manufactured in Great Britain is of this type, Fig. 2, and operates with direct injection. The designed full-load output is 3500 bhp. This particular engine is installed in Bermuda, and another unit of the same capacity is now under construction for the same site. While a few large two-cycle stationary engines have been built with trunk pistons, there has been no counterpart in

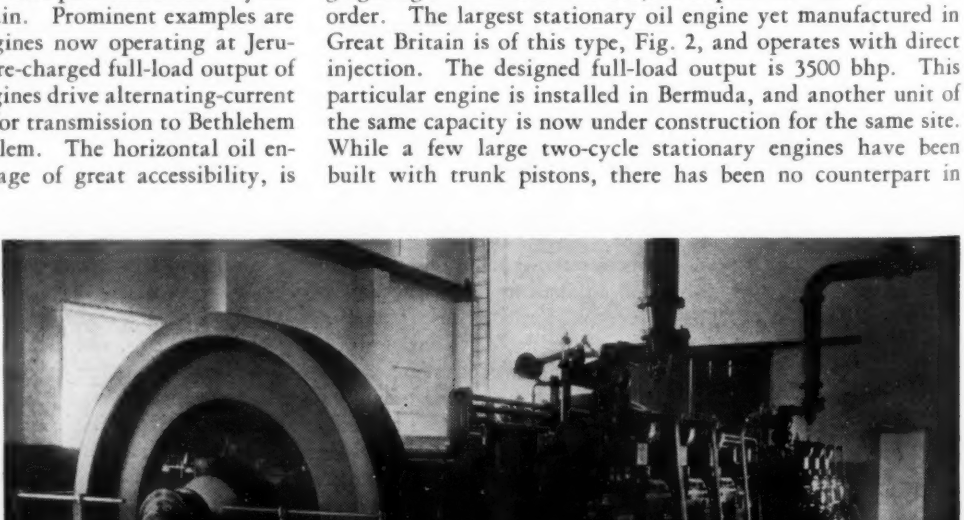


FIG. 3 HORIZONTAL GAS-ENGINE-DRIVEN AIR COMPRESSORS

Great Britain, on the scale of the important development on the continent of Europe of large two-cycle engines with trunk-guided pistons of special design and having greatly improved connecting-rod top-end bearings.

An event of some interest was the introduction during the last year of a small British two-cycle oil engine having blower scavenging, piston-controlled scavenging ports, and cylinder-head exhaust valves. In this engine, which has so far been built in one size of cylinder for multicylinder assembly, the piston is oil-cooled and the connecting rod made with a spherical small end. The published tests show a net fuel consumption at full load of 0.381 lb per bhp-hr with 67.1 psi bmep, a speed of 500 rpm, and an output per cylinder of 62 bhp. The performance and durability of this engine in commercial service will now be tested out.

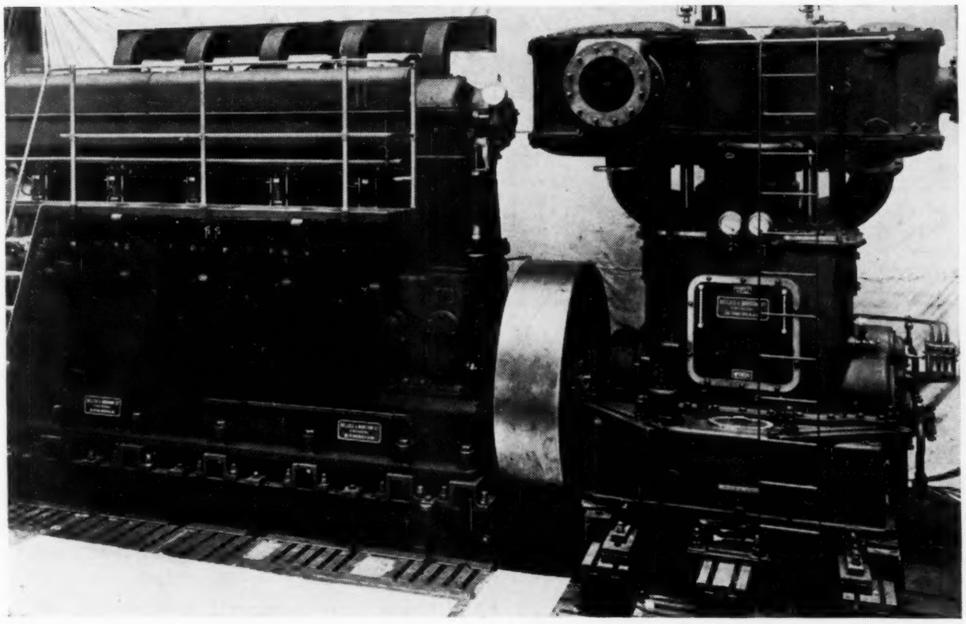


FIG. 5 AIR COMPRESSOR DRIVEN BY 500-BHP OIL ENGINE

GAS ENGINES

While the gas engine in its modern form retains moderate vitality as a prime mover, it has been much overshadowed in Great Britain as elsewhere by the oil engine. Nevertheless there are not wanting signs that in Great Britain the gas engine has an important future since any large development of bulk distribution of gas would have an important influence on the type of internal-combustion-engine plant installed. It must always be remembered moreover that the availability of immense reserves of coal and the conditions in regard to the cost and importation of fuel oil are considerations which, so far as concerns Great Britain, favor the gas engine. The leading British builder of large gas engines employs the vis-à-vis horizontal design, as shown in Fig. 3, and of this type upward of 25,000 bhp are at work. The horizontal gas engine is readily convertible when it becomes desirable to operate it as a direct-injection oil engine.

It is to be noted that during the last year much attention has been given to the development of engines which can run either on gas or on oil without any change in compression ratio. Operating on gas, a thermal efficiency of 35 per cent has been obtained from an eight-cylinder engine of 11-in. bore and 15-in. stroke at a speed of 428 rpm. At 72 psi bmep (440 bhp), the maximum cylinder pressure is 630 psi. This engine will run on any kind of gas, using oil for ignition, and it can be immediately changed over to fuel oil by shutting off the gas and removing the governor stop to allow the oil to come into full regulation. Apart from a special inlet valve, the engine embodies no moving parts other than those normal on a standard heavy-oil engine, and tests show that the exhaust temperature when operating as a gas engine with pilot-oil injection for ignition, corresponds closely to the exhaust temperature obtained on the same engine when operating as a compression-ignition oil engine.

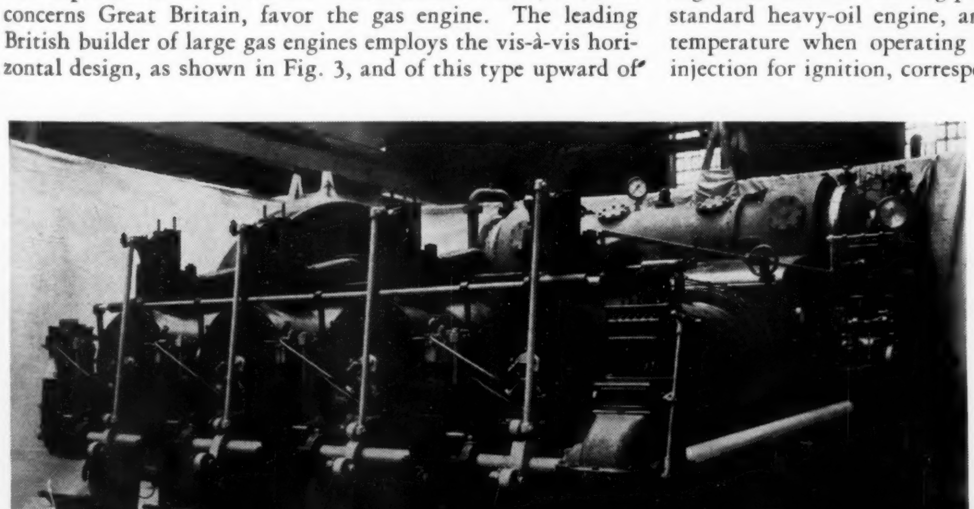


FIG. 4 HORIZONTAL OIL-ENGINE-DRIVEN AIR COMPRESSORS

Considerable research has also been carried out on the Erren engine, operating with spark ignition and alternatively, with oil-injection ignition. With spark ignition, a consumption of 7800 Btu per bhp-hr (net calorific value of gas) has been obtained from an Erren engine having cylinders $4^1/_8$ in. diam and 6 in. stroke, at a speed of 1100 rpm. It was found that the brake-horsepower output of the Erren engine with coal gas plus pilot oil ignition was substantially higher (at the same speed) than when the

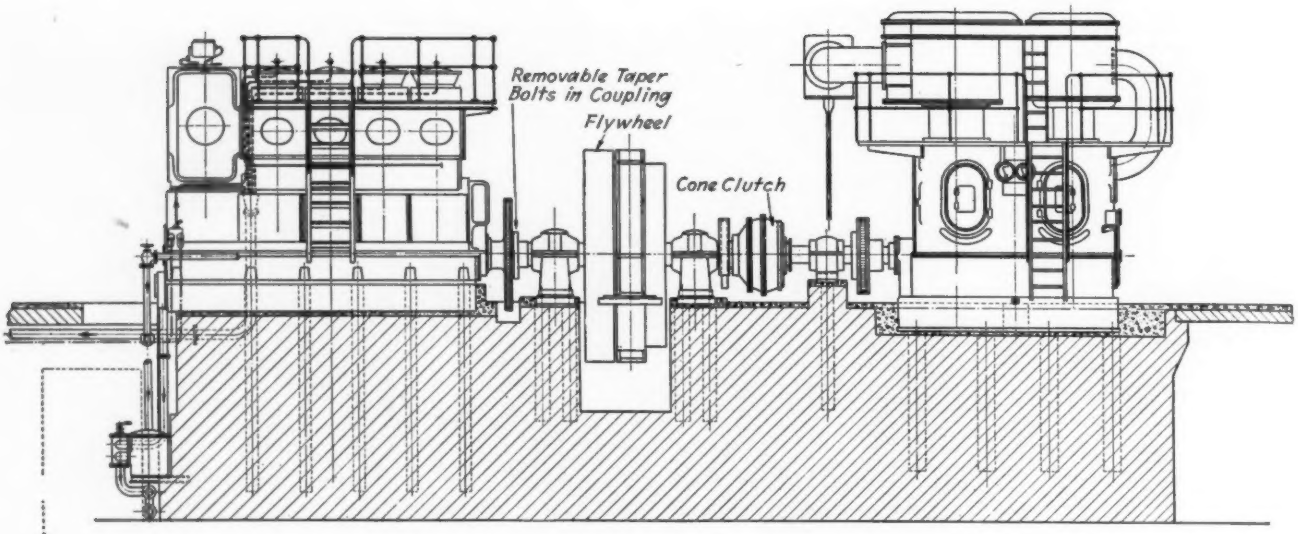


FIG. 6 COMPOSITE OIL-ENGINE-DRIVEN ELECTRIC GENERATOR AND AIR COMPRESSOR

engine was running on fuel oil alone. The compression ratio of the engine was 14.4 to 1.

AIR COMPRESSORS DRIVEN BY OIL AND GAS ENGINES

The use of oil-engine-driven air compressors is now a familiar feature in the equipment of mining companies, and these plants have given excellent service in situations where conditions are favorable to oil-engine power. Recent British examples comprise both direct-coupled types in which a standard oil engine drives a standard air compressor, and vis-à-vis types in which the air cylinders are arranged opposite the oil-engine cylinders. See Figs. 4 and 5. In practice, it frequently happens that the same standard oil engine can be used for generating electricity and compressing air, thus greatly simplifying the spare-parts requirements. The suppression of all electrical losses is a feature fully demonstrated in the ascertained air output per pound of fuel oil, that is, when comparing the over-all performance with electric drive from an oil-engine-driven generator, and the over-all performance of the same compressor direct-driven by an oil engine.

A feature of the oil-engine-driven compressor is the ease with which provision can be made for controlling the speed of the set in accordance with the demand for air, and the equipment fitted entails neither mutilation of the standard centrifugal speed governor, nor curtailment of its function in limiting the no-load speed of the engine. The speed of these oil-engine-driven compressors ranges from, say, 200 to 350 rpm according to the arrangement and size of the plant. It is of course much higher in cases where the capacity is small as, for example, in oil-engine compressor sets for blowing foghorns in lighthouses and other navigational installations. In certain examples the drive from the oil engine to the air compressor has been by V ropes, thus permitting the use at close centers of engines and compressors of standard types operating at different speeds.

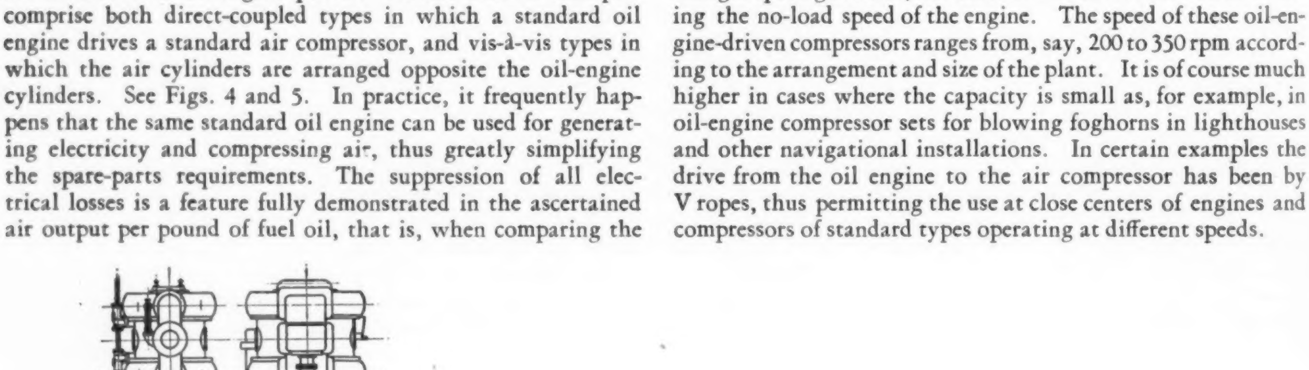


FIG. 7 COMPOSITE GAS-ENGINE-DRIVEN ELECTRIC GENERATOR AND AIR COMPRESSOR

Continuous full-load output of engine, bhp	400	Air pressure, psi	90
Capacity of generator, kw	275	Speed, rpm	200
Capacity of air compressor, cu ft per min	2000	Total net weight of equipment, tons	71.43

As an indication of the relationship between total net weight of plant and air output, it may be mentioned that in the case of direct-coupled oil-engine-driven air compressors of standard types intended for an air delivery pressure of from, say, 90 to 100 psi gage, the air output per ton of total net weight is approximately 40 cu ft per min. The fuel-oil consumption of such an equipment is about 0.56 lb per isothermal hp. The engines are almost invariably of the four-cycle type with direct injection. Apart from oil-engine-driven air compressors, a considerable number of gas engines have been supplied for direct-coupling to air compressors, with wood fuel being used in a number of cases. Some of these gas-driven compressors have been of the vis-à-vis design, convertible to oil operation.

Quite recently certain installations have been ordered in which oil engines (or gas engines) are coupled to an alternating-current generator and an air compressor arranged in tandem, with disconnecting gear between the generator and the compressor, Fig. 6. With such equipment the same engine can be used for augmenting either the electrical or the compressed-air output. Moreover, by bracket-mounting the field ring onto the engine flywheel and using fabricated construction for the field ring and stator, the additional weight due to the intercalation of the generator is comparatively small relatively to the weight of the engine and air compressor, Fig. 7.

RAILWAYS

Great Britain has nothing to show in the way of heavy fast oil-engine-propelled railway trains for long-distance main-line service. Experiments have been made with oil-engine rail cars using electric, hydraulic, or mechanical transmissions, and much detailed study has for years past been given to the possibility of employing oil engines for heavy main-line traction. The results of experiments and study have not disclosed, up to the present, any inducement which could justify the replacement by oil engines of the steam locomotives hitherto used in handling fast and heavy express passenger trains on the British main lines. It can be said moreover that, so far as such trains are concerned, there seems to be little prospect of any development in oil-engine traction in Great Britain. There are not wanting, however, indications that appreciable development may take place as a result of experiments now being carried out with oil-engine-driven rail cars and trains for interurban and branch-line services. This is a field in which there seems to be good scope for the use of oil engines, and so far, it is being tackled on the basis of rail cars and multiengined train sets.

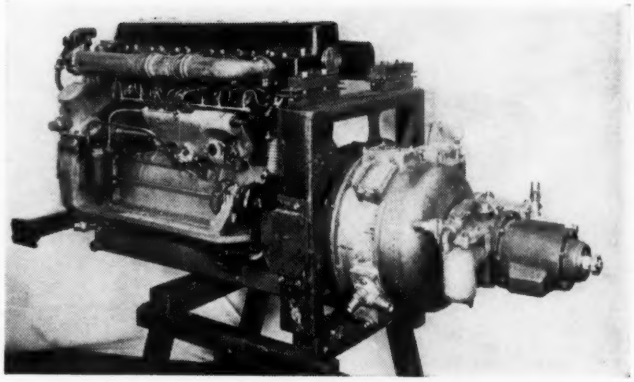


FIG. 10 OIL ENGINE WITH HYDRAULIC TORQUE CONVERTER USED ON LIGHT TRAIN OF FIG. 9

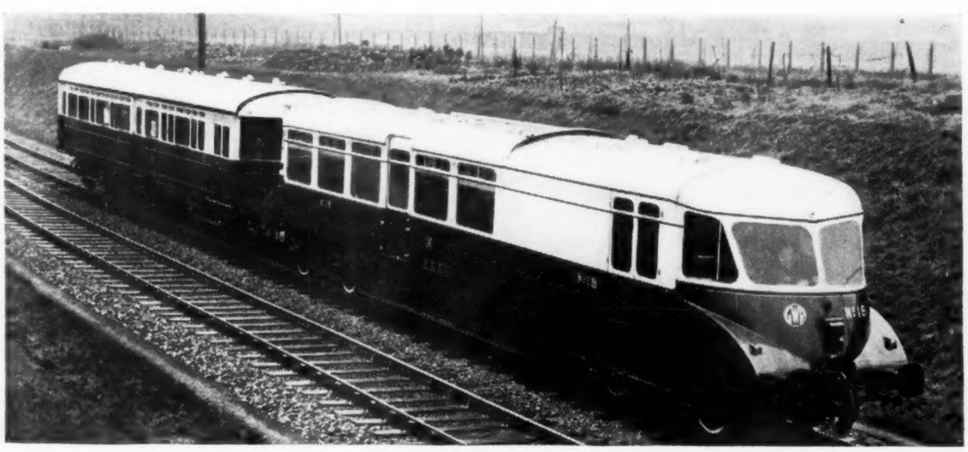


FIG. 8 OIL-ENGINED MECHANICALLY DRIVEN RAIL CAR WITH TRAILER—GREAT WESTERN RAILWAY

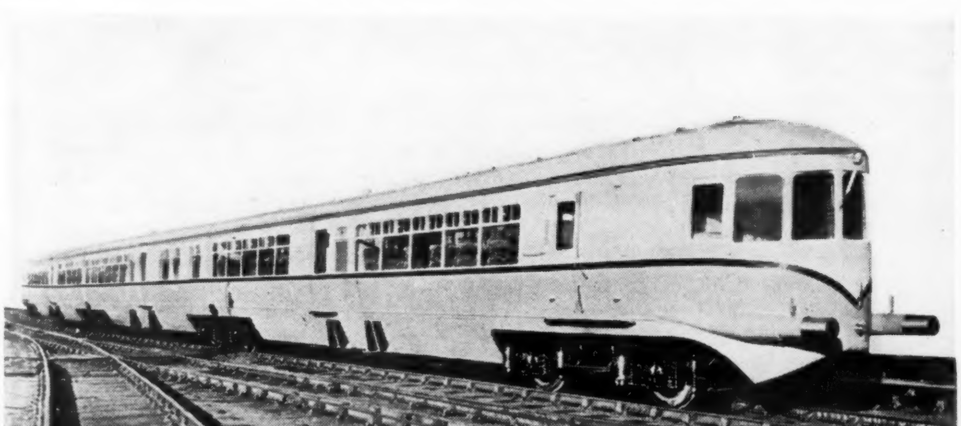


FIG. 9 THREE-CAR LIGHT TRAIN OF THE LONDON MIDLAND & SCOTTISH RAILWAY
(Six oil engines, hydraulic drive.)

On the Great Western Railway, which introduced rail cars on its system about five years ago, there are now in operation 18 cars, all of which are fitted with six-cylinder four-cycle oil engines of a design extensively used on passenger road vehicles except that the rail-car engines have comet heads, whereas the road-vehicle engines have direct-injection heads.

The first of the Great Western Railway rail cars was fitted with one engine; all later rail cars have two, mounted on the outside of

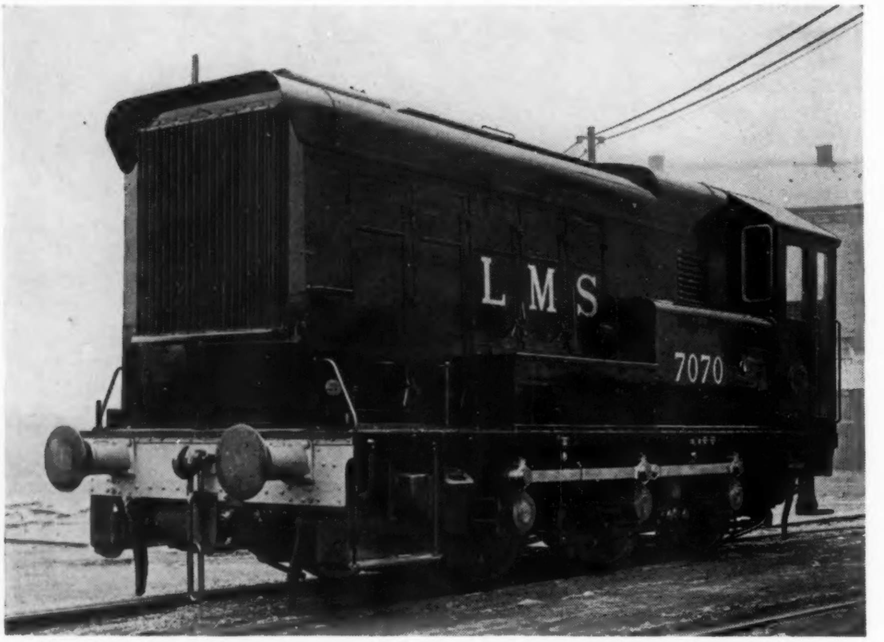


FIG. 11 OIL-ENGINED ELECTRICALLY DRIVEN SWITCHING LOCOMOTIVE OF THE LONDON MIDLAND & SCOTTISH RAILWAY

the main underframe below floor level. The drive is mechanical. Up to Dec. 10, 1938, the mileage of the first of these rail cars was 267,157, and at the present time the daily mileage of the Great Western passenger rail-car services is 3592, representing 3 per cent of the total daily passenger-train mileage on the system. The seating accommodation in these rail cars varies from 44 to 70, according to the internal arrangement and luggage space.

The last rail car put into traffic on the Great Western Railway, Fig. 8, has a tare weight of 33.6 tons, which includes the automatic train-control equipment, as well as two exhaust-gas-heated boilers and water tanks for trailer heating. Each of the two engines has an output of 121 bhp at 2000 rpm, so that the engine power per ton of tare weight (rail car without trailer) is 7.2 bhp. There are now on order for the Great Western Railway 20 rail cars of similar type.

Fig. 9 shows an example of the multiengined train set which appeared during 1938 on the London Midland & Scottish Railway. A three-car train has been introduced after detailed experiments with individual oil-mechanical rail cars of the two-axle type. In this three-car train there are six four-cycle six-cylinder oil engines driving six of the eight axles, Fig. 10. Each 8.6-liter engine is rated to develop 125 bhp at 2200 rpm, making a total of 750 bhp. Hydraulic torque converters are employed. The dry weight of each engine is 1340 lb, or 10.7 lb per bhp. The service weight is 1430 lb, and the total weight of each set of equipment including engine unit, transmission, mounting, radiator, control gear, and tanks filled for service, is 4170 lb, or 33.4 lb per bhp. The collective tractive effort is, at starting, 17,500 lb, at 75 mph, 3300 lb. The cylinder heads of the engines are of the air-cell type. Otherwise they are of the same design as would be supplied for road vehicles. The total tare weight of the train is 75 tons, so that the engine brake horsepower per ton of train weight is 10. This may be compared with the oil-electric two-car trains of the Belgian National Railways, where for an engine output of 410 bhp and a tare weight of 70 tons, the bhp per ton of train weight is 5.85. In both cases the designed maximum speed is between 70 and 75 mph. So far as the British railways are concerned, passenger rail-car equipment is developing on the basis of both mechanical transmission and hydraulic transmission.

The tendency is, it will be seen, to develop rail-car services for feeder and secondary main lines. These are the services which have been most severely affected by competition from road vehicles, and it has already been shown that close attention is being given to reduction in tare weight, so that the engine output per ton of weight may be made as large as possible, and the acceleration correspondingly increased. It must be admitted, however, that, with the circumstances obtaining at present, it is easier for the engineers to produce the equipment called for than it is for the commercial departments of the railways to induce the traffic back from the roads.

SHUNTING LOCOMOTIVES

In regard to the use of oil-engined locomotives for switching and yard purposes on the British railways, it is to be noted that definite progress has been made. The result of careful study given to the operational history of the engines already at work discloses that for continuous service, i.e., where a shunting locomotive is to be kept in uninterrupted use from Monday morning until Saturday night, the one-man-operated oil-engined locomotive proves itself superior to the steam locomotive. On the London Midland & Scottish Railway approximately thirty oil locomotives are already in service, the majority of which have electric transmission, Fig. 11. The six-cylinder four-cycle engine unit in the oil-electric locomotives has a full-load rating of 350 bhp at 680 rpm, and the weight of the complete locomotive in working order is 50 tons. Twenty more oil-electric locomotives are now on order for this system, and other railways are experimenting with them.

Large numbers of oil locomotives are at work in the mining, metallurgical, and other industries in Great Britain, and the use of this type of equipment has greatly extended in connection with the activities of public-works contractors. Most of the engines are of the four-cycle type, some with supercharging blowers, though two-cycle engines are also used in this class of service.

RAIL CARS FOR EXPORT

Large numbers of rail cars have recently been built by British makers in which the power unit consists of a four-cycle six-cylinder oil engine of a type widely used in road vehicles. The engine is bogie-mounted and develops approximately 100 bhp. With fluid flywheel and compressed-air-operated epicyclic-gear transmissions, these oil-mechanical rail cars are designed for four track speeds. Each rail car has one power bogie and one trailing carrying bogie, and the advantage of standardization of chassis details has been retained without sacrificing flexibility of interior arrangement. For example, on one order for 99 rail cars, five different types of interior arrangement are embodied without disturbing interchangeability of bogies, power and transmission equipment, underframes, or body framing sections.

A further tendency in the design of rail cars for export to India and elsewhere is seen in the evolution of an arrangement

enabling the cost of the equipment to be reduced to bed rock, with the object of countering more effectively, cutthroat competition from road vehicles. In these light rail cars, or rail omnibuses, a standard V8 gasoline engine has been used, together with truck-type gearbox and the simplest possible mechanical transmission, assembled on an electrically welded two-axle chassis with light but weatherproof bodywork. A 40-seater rail omnibus of this type has a tare weight of 4.15 tons, and the f.o.b. cost of the complete vehicle is at the rate of approximately £30 per seat. Gasoline consumption (including stops and warming up) is found to be about 13 miles per gallon on level track at an average speed of 25 mph, with stops at intervals of approximately two miles. A speed of 45 mph is attained in 90 sec, a result consequent upon a horsepower-to-weight ratio of about 20, which is higher than what is provided in many road vehicles of approximately the same seating capacity. The air brakes fitted on these gasoline-engine-driven rail cars give an average stopping distance (from 40 mph) of 373 ft. Since the power unit is entirely standard, servicing is simplified and the road vehicles come up against an extremely tough proposition, particularly when the road and railway are closely adjacent throughout the route covered. In the case of rail omnibuses, it is the more imperative that the rail horsepower per ton of weight be increased as much as possible by lightweight construction of the vehicle.

ROAD TRANSPORT

The registrations show that there are at present in Great Britain approximately 26,000 road vehicles equipped with heavy-oil engines. Of these, roughly 15,000 are passenger-carrying vehicles; the remainder are goods-carrying vehicles of various types. The figures do not include vehicles in which the original gasoline engines have been replaced by heavy-oil engines, and an idea of the extent to which such conversion has been carried out is conveyed by the fact that one engine builder alone has supplied 1500 oil engines for this purpose. The average size of oil engine used in Great Britain for road transport has a capacity of about eight liters, though engines up to ten-liters capacity have been constructed for this purpose. While six-cylinder four-cycle units are usual, large numbers of four- and five-cylinder engines are built. A considerable proportion of the total number of road-vehicle oil engines have antechamber injection, though direct-injection combustion chambers are widely used.

As to transmission, it can be said that five-gear boxes are gaining ground, and in some fleets there is a movement toward dog-engaged gears without synchronizing clutches. The majority of new passenger road vehicles for town service are equipped either with fluid flywheels or torque converters.

For braking, in the case of larger vehicles, auxiliary power is used. With gasoline engines (still extensively employed on long-distance luxury coaches), the Dewandre vacuum-brake system using vacuum from the induction pipe is a customary fitting. With compression-ignition engines this is not available, and an exhauster pump is fitted to the engine. As this gives a comparatively small capacity, a vacuum storage tank is provided thus affording capacity for several brake applications. The regulations call for an indicator to show the driver the state of the vacuum. Electric starting is universal on passenger vehicles, though some makers provide decompression allowing for hand starting. Twenty-four-volt alkaline batteries are usual.

There are no passenger road vehicles in Great Britain similar to those "Battleships of the Reichsautobahn" which may be found on some of the motor roads in Germany. This is due of course to the circumstances in Great Britain which render tare weight of such importance (the limit is $10^1/_2$ tons laden, double-deck) and to the legal speed limit of 30 mph. In Great Britain, moreover, passenger vehicles are not permitted to haul trailers.

As an example from passenger-vehicle practice, the latest type of double-deck omnibus for the London Passenger Transport Board with seats for 56 passengers has a tare weight of 6.6 tons, and is equipped with a direct-injection four-cycle oil engine giving 90 bhp at 1700 rpm; the output per ton of tare weight is thus 13.64 bhp. Large numbers of these engines are in use.

When given good maintenance, smoke and smell give no cause for complaint against the oil engine. At the outset, public opinion was hostile to its use in passenger vehicles, and one large municipality quietly introduced 30 oil-engined omnibuses before advertising for 100 more. When the public raised an outcry, they were informed that they had been traveling in 30 of the busses for upward of six months without knowing anything about it. The agitation then subsided and has since ceased.

It is indicative of the potential importance of mechanized road transport, in which the heavy-oil engine plays so prominent a part, that the British Minister of Transport should have recently prepared a scheme under which all goods vehicles will, in the event of a national emergency, be adequately organized. This scheme, which utilizes certain existing supervisory arrangements, is being prepared in time of peace so that it may operate with rapidity and with the least possible confusion in time of war.

While this review does not cover gasoline engines, it may be mentioned that during 1937 the production of private cars in Great Britain amounted to 389,633. Incidentally, the Ministry of Transport annual return issued during February, 1939, showed that in September, 1938, the number of mechanically

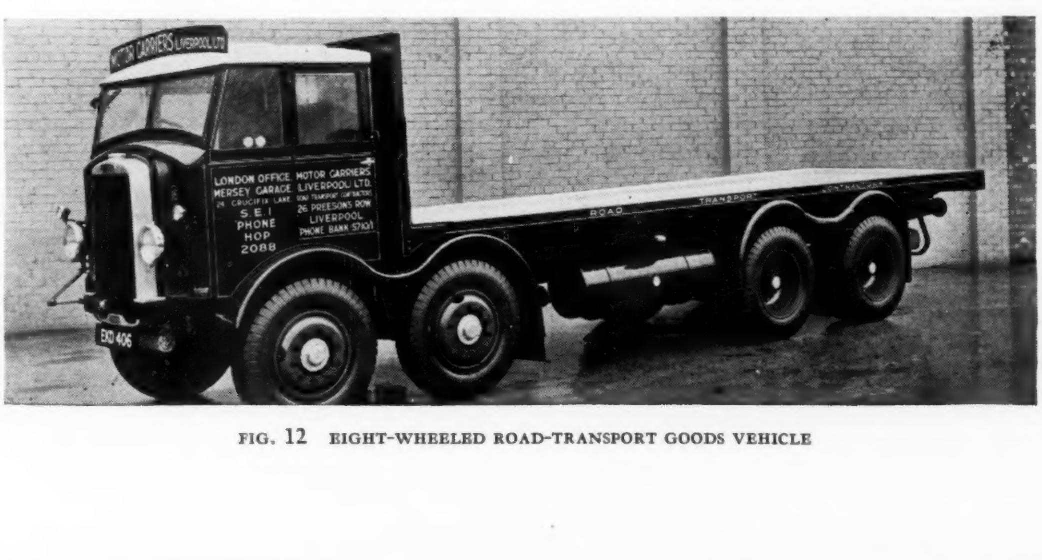


FIG. 12 EIGHT-WHEELED ROAD-TRANSPORT GOODS VEHICLE

propelled road vehicles in Great Britain was 3,093,884. Of these, 1,944,394 were private cars.

MARINE OIL ENGINES

The types of oil engines used for marine propulsion by British shipowners show no evidence yet of definite stabilization down to one or two types, and each of the principal firms designing marine oil engines persists with its own distinctive arrangements and details. Most of them build both two- and four-stroke types, and the two-stroke types include trunk-guided single-acting engines, crosshead single-acting and double-acting engines, and opposed-piston engines, all with direct injection. The general engine types used in recent tonnage have been roughly as follows:

For vessels with engines up to 1500 bhp (chiefly coasters), four-stroke trunk-guided and two-stroke trunk-guided engines in fairly equal proportions, though the use of the latter type tends to increase.

For oil tankers (usually with engines ranging from 1500 to 4000 bhp) four-stroke engines generally supercharged have predominated, though the two-stroke opposed-piston type has also been widely used. In some cases (though a minority as compared with those already mentioned) two-stroke single-acting engines have been used for this class of vessel.

In the case of cargo and passenger vessels with engine power higher than 1500 bhp, there have been few recent installations of four-stroke engines. The types used are two-stroke single acting crosshead engines, two-stroke single-acting opposed-piston engines, and two-stroke double-acting. Double-acting types predominate for the higher powers, single-acting for the smaller sizes, although both types are used for all powers above 3000 bhp in a single engine. The two-stroke trunk-guided engines have not yet become numerous in sizes larger than 1500 bhp, but this type is growing increasingly popular and the engines are being built in progressively larger sizes, having already reached about 6000 bhp per engine.

For cross-channel and similar services, the high-speed ship of small tonnage has until recently been exclusively steam-driven. Some years ago a few of the slower vessels of this class were fitted with four-stroke trunk-guided oil engines, and while they have done well in service, their limitations in respect to space and weight prevented their general adoption in this class of service. The development of comparatively high-speed two-stroke engines of large power has, during the last year or two, caused a swingover so that most of the recently completed cross-channel ships have been fitted with two-stroke single-acting engines. The majority of the engines in these vessels are of the trunk-guided two-stroke type running at speeds of from 250 to 400 rpm, and the total power in twin screws ranges from 3000 to 6000 bhp. The largest and fastest vessels are those belonging to the Belgian State Railways, *Prince Baudouin* and *Prince Albert*, in which twin-screw two-stroke crosshead-type engines developing collectively 17,000 bhp at 268 rpm are installed. These vessels are of 3000 tons, and with a speed of over 25 knots are the fastest of their size which have yet been built. It should be mentioned here that the Belgian cross-channel vessels, with their engines, are of Continental design and construction.

In regard to the general tendency of marine-engine design, the four-stroke unsupercharged engine is being used less, and the four-stroke supercharged engine, which had a brief run of popularity some years ago, has now almost disappeared from new marine work in Europe except for use in oil tankers. The double-acting two-stroke and the single-acting crosshead two-stroke types share the bulk of the new business for higher powers, while for lower powers the trunk-guided two-stroke type appears likely to become universal, and is now frequently being employed for higher powers. In Great Britain, the opposed-piston two-stroke engine enjoys a steady popularity particularly for vessels of from 2000 to 6000 bhp.

There has not yet been any appreciable movement, in Great Britain, on the lines so largely followed in recent German marine practice, where oil-electric drive with alternating-current transmission to the propellers has become popular. The engines used are of the two-stroke trunk-guided type, and it is to be noted that they are identical with the engines which would be supplied for installations on land.

RESEARCH

While it is not part of the purpose of this paper to cover the scope of research work directed specifically to oil engines, it is to be noted that in Great Britain, as elsewhere, active research is being carried on in connection with the development of this type of machine, particularly in engines of high power-to-weight ratio for traction and aviation purposes.

Since the early labors of such pioneers as Rudolf Diesel and Akroyd Stuart, oil-engine development has been greatly assisted by the efforts of patient and practical men, who have frequently made most progress through what might be deemed their failures. "It is a great thing," observed James Watt to his ingenious assistant Murdock, "to find out what will not do." Indeed Watt contemplated, at one time, publishing what he called a "book of blots," thus following the idea so finely expressed by Waller in the oft-quoted lines:

> "Poets lose half the praise they would have got,
> Were it but known what they discreetly blot"

This applies equally to engineers, and there should never be a tendency to suppress those records of trouble and difficulty which form the very foundation of technical progress.

The cooperation of the engine user with the designer and the research engineer has been, in recent times, of the highest value. Robert Sulzer, in a recent lecture before the Koninklijk Instituut van Ingenieurs, Rotterdam, gave the following admirable expression to the advantages of such cooperation: "In solving new design problems, the engine builder has to rely partly on his own investigations, and partly on communications received from users of the engines. But experience regarding difficulties in service, however valuable they may be, point only to some hidden defect in the engine; in order to remove the trouble it is necessary first of all to find out the cause of the difficulties. Sometimes this is at once perfectly clear; but in many cases, and particularly with greater development of technique, it can be determined only by making certain thorough investigations." Mr. Sulzer further stated that "in all these cases it has proved to be of the greatest possible advantage and particularly fruitful when the experience made by users and builders has been mutually exchanged and embodied in the new design."

These words epitomize the basis upon which oil-engine research can best proceed. It is because the research engineer has become more practical in outlook, the engine builder more scientific, and the engine user more vigilant that such remarkable progress has been made in recent times with the two-cycle engine. This happy combination will become more powerful in effect as time goes on, and increasing recognition is given to the value of cooperation between the designer and the user.

In conclusion, there must always be criticism directed to improvement. On the value of this, there is no better expression than that uttered by Pasteur:

"Cultivate the spirit of criticism. By itself it is not a generator of ideas nor a stimulus to great things. Without it nothing will avail. With it will always remain the last word."

IMMERSION QUICK FREEZING

Its Application to Rural Processing Industry

By JOHN P. FERRIS and R. BROOKS TAYLOR

DEPARTMENT OF AGRICULTURAL INDUSTRIES, TENNESSEE VALLEY AUTHORITY

A PROPOSED method of freezing perishable foods by immersion was described in a British patent 97 years ago (1).[1] The product was shown encased in packages. However, the immersion of foods in direct contact with a moving stream of cooling fluid without containers seems not to have been considered seriously by engineers in this country until recently, although such a method appeared to offer possibilities of rapid heat removal and hence of quick freezing.

The experimental program, which will be described, was started about four years ago. Perhaps the most novel matter in connection with this development lies in its purpose—to determine a specific opportunity for a rural industry. Increasing income to farmers, essential to soil conservation, was in view. It was intended that the commercial introduction of the process should be accomplished in a manner which would make some small contribution toward the solution of one of American democracy's most fundamental and puzzling problems—that of achieving urban-rural cooperation. Before going into the technical phases of the project, it therefore seems appropriate to indicate the economic background and to give a general statement concerning the objectives.

THE NATIONAL PROBLEM OF INDUSTRIAL AND AGRICULTURAL BALANCE

Many spokesmen of business, of agriculture, and of government have, during the last few years, advocated greater integration of agriculture and industry. There is a growing conviction that the nation will be stronger, more vigorous, more secure, if somehow a better relationship can be worked out between city populations on the one hand and rural populations on the other; or, stating it somewhat differently, between the commercial and industrial centers on the one hand and the outlying areas supplying raw materials on the other. Throughout the country thoughtful people have been searching for solutions.

Industrialists of vision have recognized the interdependence of urban and rural populations. About 1926, Guy Tripp, chairman of the board of directors of the Westinghouse Electric and Manufacturing Company, proposed that industry assist in developing rural income as a means of building up rural markets for industrial production (2). Rural areas everywhere are one of the nation's new frontiers, taking the place of the old westward-moving geographical frontier, which is gone.

Here, at these internal frontiers, established industry is visualizing one of the great opportunities of raising the national income. The Ford Motor Company has for years had many parts manufactured in small scattered factories, most of them in localities which are primarily rural. According to a recent report (3), twelve are in operation, and Henry Ford is convinced that the development is sound. In 1934 these factories produced $8,000,000 worth of parts and tools, employed 2500 workers, and paid $1,500,000 in wages (4). At Saline, Michigan, locally grown soybeans are processed for use in automobile parts and manufacturing operations.

Agriculturists call attention to the fact that technology has displaced far more farm workers than workers in manufacturing. The National Industrial Conference Board confirms this (5); in 1870 about 180 persons per thousand of the population of the United States were employed in agriculture, whereas in 1930, two generations later, about 89 persons per thousand were so employed—relatively only half as many. Students of rural conditions have concluded that this striking effect of technical progress in agriculture upon agricultural employment will continue in the future, since the potential demand for food products has physical limits; on account of this, and because the birth rate in rural areas is so much higher than it is in the cities, the present surplus rural population will increase. Hence they say, employment in industry, services, and so on, for which potential demand has no physical limits, should continue to increase, relative to employment in agriculture.

They recognize that vast numbers of city dwellers are unemployed, and that industry too has a problem of surplus workers. To restore a balance, they point out that one must add weight at the light end of the scale beam. The rural population has, on the whole, suffered most from rural-urban maladjustments. Apparently, per capita income in the present concentrated centers of manufacturing has for a long time been more than half again as high as the per capita income received by the rural population (6). The disparity seems to have been increasing. The present advantage of the urban population is, no doubt, temporary. Ultimately, the prosperity of cities depends upon the prosperity of their hinterlands—as illustrated by the slow economic paralysis which descended upon Vienna during the twenty years after 1918, as a result of the loss of its hinterland regions in the Danube Valley. Hence, their suggestion is to build up the rural areas economically by diffusion of small-scale industry, in order to create new wealth, provide new employment, and restore the economic base of rural life.

Engineers, too, have been giving thought to these questions. Goodrich and Davis have applied the method of engineering analysis to the formulation of a proposal for a given area (4). They note that certain government reclamation projects create new agricultural communities, which in turn present opportunities for industrial development to serve local and near-by needs. As an illustration, they studied the Madera Irrigation District, comprising some 175,000 acres located at about the geographical center of the State of California, in the great central valley formed by the Sacramento and San Joaquin rivers. Based upon the present and estimated future population of California, they tabulated the state's assumed potential consumption of manufactured products, subtracted present manufacturing production, and calculated the volumes of products which new local plants might supply. They then estimated a suitable allocation to the Madera District, and made a proposed list of manufacturing enterprises which, if established, should create a healthy balance of industry with agriculture. The

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Process Industries Division for presentation at the Semi-Annual Meeting, San Francisco, Calif., July 10–15, 1939, of The American Society of Mechanical Engineers.

agricultural processing industries on the list account for about 40 per cent of the total estimated employment.

Their conviction is that the nation would gain if throughout the country there were many areas of diversified agriculture and industry, and a closer approach to balance between production and consumption with each of these areas. On the basis of their supporting data they believe the tendency would be to lower costs of production and especially of distribution—the essential basis for increased consumption and a higher level of income. Such communities, they say, would provide better surroundings for wholesome living and working than most of the present impoverished countrysides or overcrowded cities. Periodic shutdowns seem to be characteristic of American industry, and, at present, the labor of the temporarily unemployed workers is entirely lost. Goodrich and Davis think that this otherwise lost labor might be devoted to agriculture, in the organized production of foods for consumption within the community. (Those who represent established agriculture, however, continue to urge, as stated previously, that industry, services, and so on, should absorb an ever larger proportion of America's "working time." Their conclusion is based on the long-time prospect for a continued reduction of employment in agriculture relative to employment in industry. Hence, they argue, it would be more appropriate to develop a program in which local manufacturing employed the labor which agriculture cannot fully employ.)

As to the advantages of a greater diffusion of industry generally, and without regard to the particular proposal advanced by Goodrich and Davis, two additional considerations should be pointed out: First, it would increase the nation's military strength. At present some 52 per cent of the nation's manufacturing is concentrated within a narrow strip along the deep water margins. This exposure to attack and economic dislocation in case of war constitutes a definite military weakness. Second, periodic industrial unemployment could best be absorbed in areas of diversified agriculture and industry; this advantage is important, because the United States as yet has found no way of eliminating unemployment.

The economic system under which the country operates provides no protection for new industries against competition from established centers of production. The attitude of the latter is ordinarily that they are entitled to any new markets which may be opened up anywhere in the nation. And there is now no method of restricting the sales of new industries to any specific area.

Goodrich and Davis do not, however, propose the immediate creation of new industrial regions in the new agricultural areas referred to. They selected one of these areas in order to illustrate the need for and possible benefits of industrial production balanced with agriculture. Such developments, they said, can come only slowly, as a result of full understanding, and following thorough engineering and economic research. In closing, they say, "Engineers should be willing to assume a large measure of responsibility . . . ."

CREATING NEW INCOME IN DEPLETED RURAL AREAS

The problem of agricultural and industrial balance is particularly acute in some of the country's existing agricultural regions which are characterized by widespread impoverishment of soils, and a deficit trade balance. In many such areas, the outgo exceeds income; the "books" are balanced by continued depletion of resources and increasing debt to other areas. The startling displacement of agricultural employment referred to previously has, of course, occurred chiefly in agricultural regions. In the Southeast, it has produced a surplus rural population estimated at 1000 to 1800 workers in typical rural counties.

Furthermore, farm incomes tend to be low under these conditions, \$100 to \$300 annual net cash income per family being quite common in the rural Southeast. Sheer necessity is forcing farmers to cultivate every available acre, including millions of acres of hillside land which quickly erodes under such treatment, and which should ultimately be in grass or in forest cover. Ways must be found of keeping the plough off about half the hillier land, and of multiplying the income from the more level lands that remain under cultivation.

The sound, long-time method of increasing income, while at the same time using less land, is not subsidy but enabling the people themselves to create the new income. On the agricultural side, the solution involves diversification and improvement of crops, increasing cover-crop acreage and livestock, and better marketing. It is equally important to process some of the crops locally, before they go to market, thus adding value to them. This increment of value and income is created when industry applies scientific knowledge, engineering brains, and labor to a raw material. Those interested in specific opportunities for further diffusion of manufacturing into rural areas should explore the field of agricultural-processing industry. One logical place to start is in existing agricultural regions that are in economic trouble.

COORDINATED ENGINEERING, AGRICULTURAL, AND MARKET ECONOMIC RESEARCH APPLIED TO THE PROBLEM

However, finding concrete opportunities for the industrial processing of farm crops is not just a matter of pointing the finger; it is necessary to analyze the agricultural problems of producing satisfactory grades of the crops available, to study thoroughly the markets in which the crops might be sold in processed form, and to solve the engineering problems involved in transportation and in the processing operations.

The authors have found little record of engineering, agricultural, and market research directed toward uncovering specific opportunities for manufacturing enterprises capable of operating successfully in rural areas. The immersion process of quick-freezing foods described in this paper is the result of coordinated research and investigations embracing agriculture, market economics, and engineering. Both laboratory experiments and demonstrations on a pilot-plant scale were included. Appropriate phases of the research and demonstration work were carried out by each of five public agencies: The engineering experiment station, agricultural experiment station, and agricultural extension service of the University of Tennessee; the agricultural experiment station of the University System of Georgia; and the agricultural industries department of the Tennessee Valley Authority.

The analysis indicated that the food processing industries are likely to develop further in the southeastern area. It has been estimated that the South has been buying about a billion dollars worth of human and animal foods from other regions annually. Of this about \$400,000,000 worth has been bought by farmers. Income from the South's principal cash crop, cotton, has been declining precipitately, and everything points to further decreases of purchasing power from this source. Hence, the South is being forced not only into growing more foods but also into processing them in the region. It is also estimated that the American market will ultimately demand about one third of its vegetables, fruits, and meats in fresh form, about one third canned, and about one third in frozen form. Because of this trend a number of canners have found it necessary to undertake freezing operations, in addition to canning.

In connection with studies of some of the raw materials in the Tennessee Valley region which might be processed locally, it was noticed that several strawberry-producing regions had lost important markets on account of the shift of demand from

fresh fruit to frozen fruit. See Fig. 1. It was also noticed that the area's income had suffered considerably from its failure so far to participate to any appreciable extent in the rapidly growing business of manufacturing frozen foods. In Tennessee, for instance, most of the strawberry crop was sold on the fresh markets, and there has been a serious decline in the production recently. In 1922 to 1927 Tennessee's production averaged about $9^1/_2$ per cent of the nation's strawberry crop, showing that soils and climate are suitable for economic production. In 1934 to 1938 the average percentage had fallen to about $6^1/_2$ per cent. The seriousness of this situation in counties in which strawberries constitute a principal source of cash income is therefore apparent.

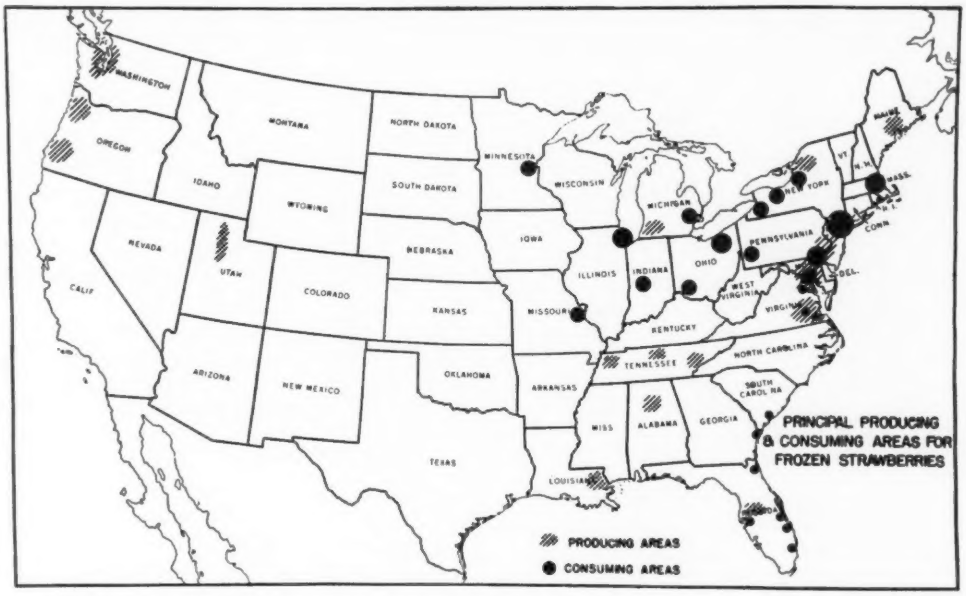


FIG. 1 MAP SHOWING LOCATIONS OF PRINCIPAL STRAWBERRY PRODUCING AND CONSUMING AREAS IN THE UNITED STATES

The Agricultural Experiment Station of the University of Tennessee conducted a study of the marketing of frozen fruits and vegetables (7) which showed that the markets have been increasing rapidly. In 1927 only about 37 million pounds (fruits and berries only) were frozen and in 1937 this had increased to some 225 million pounds (including vegetables). The estimated total for 1938 is 290 million pounds—a 29 per cent increase over the previous year. This market study, however, showed that for the producers merely to attempt to engage in freezing was not enough, in spite of the rapidly increasing demand for frozen products in general; this is because there have been surpluses of some of the older types of frozen products on the market.

The great increase in demand is for the highest-grade products for the consumer trade. In 1934 there were only about 200 retail stores equipped with zero Fahrenheit refrigeration, which is necessary for retail distribution of high-grade frozen products. By 1938 this figure had increased to about 5000, and the number is continuing to increase rapidly. Furthermore, the ice-cream companies already have low-temperature storage and insulated trucks in practically every city and large numbers of them have gone into the business of distributing frozen products.

FREEZING OF PERISHABLE FARM CROPS

The preservation of strawberries and some other fruits by freezing with admixed sugar in various proportions has been commercial practice for a number of years. In the early 20's Clarence Birdseye developed a method of freezing by placing the products in containers between two metal surfaces which carried the heat away. Freezing was much faster than in some earlier processes, and he named it "quick freezing." This and other methods of quick freezing have become nationally and internationally known.

Until recently the term "quick freezing" was relative, referring generally to that speed of freezing which would result in the product being completely frozen in approximately 90 minutes or less. Recently, however, J. G. Woodroof (8) has proposed that it be defined as freezing which progresses through the body of the product at 0.3 centimeter per minute or faster. At this speed ice crystals are small enough so that, in general, cell walls are not ruptured.

Making definite recommendations concerning the adaptation of any one of the known processes into the agricultural economy of the Tennessee Vally region involved agriculture, engineering, and economics; hence, a solution involved work in all of these fields.

As to agriculture, it was necessary to determine how to produce a series of commodities of the proper varieties and maturing at proper times, so that it would be possible to operate freezing plants continuously over periods of six months or more. It was also necessary that farmers should learn how to produce these products of acceptable quality and uniformity, so that freezing plants might operate smoothly and efficiently.

As to engineering, the problem consisted of finding an available process which would be capable of economic operation on a relatively small scale, as well as with larger production; a process requiring a relatively low investment in plant and equipment; one using machinery readily capable of freezing a series of different commodities having different characteristics; and a process using equipment which could be adapted for freezing in canneries, supplementing the ordinary canning operations. Maximum-size freezing machines were to be capable of at least 2000 lb of product per hr, and much smaller units were to be feasible for smaller operations. Finally, the machinery was to be so simple that the ordinary supervisory type of personnel working in canneries would be able to operate it without difficulty.

It did not seem likely that concerns already engaged in quick freezing would take much interest in regions in which most of the producers could at the outset offer only limited varieties of crops suitable for freezing, in relatively small acreages on farms which are scattered rather than concentrated. Furthermore, adequate storage and transportation facilities were lacking. In fact, officials of large food-processing corporations, while investigating sources of raw materials in the area, expressed this viewpoint to a prominent representative of a group of farmers who produce strawberries, youngberries, and peaches.

The agricultural experiment station of the University of Tennessee undertook to develop new varieties of strawberries

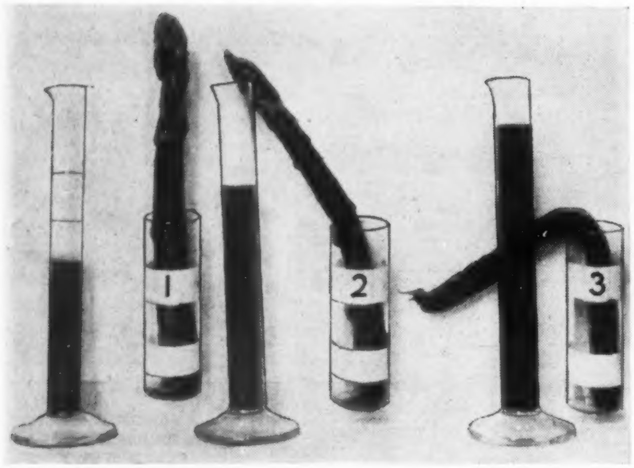


FIG. 2 STALKS OF ASPARAGUS FROZEN IN LABORATORY BY THREE DIFFERENT METHODS[2]

(1) Frozen at 0 F by immersion in invert sugar syrup; (2) frozen at 0 F on metal plate; and (3) frozen at 0 F in paper-board carton

which would be more adaptable to this form of preservation than the varieties which at the time were in favor with the growers. From the many thousands of seedlings grown, selections were made and tested with various existing methods of freezing. Improved strains were developed, and these may shortly be available for propagation commercially.

The work of Birdseye (9, 10) demonstrated the fact that high-speed freezing produces relatively small crystals, which cause less damage upon defrosting than the larger crystals produced by the slower methods of freezing. Woodroof and Bailey (11) showed that very low temperatures were detrimental to the quality of some types of frozen products. H. C. Diehl (12) reported, ". . . . investigations in this laboratory (Frozen Foods Laboratory, Bureau of Chemistry and Soils, U.S.D.A.) have indicated, among other things: . . . . the desirability of obtaining rapid and uniform heat transfer in the product at moderate freezing temperatures . . . . ." Donald K. Tressler (13) summarized his comments on quick freezing as follows: ". . . . . From those reviews it is seen that in general the main advantages of quick freezing over slow freezing are the following: (*a*) The ice crystals formed are much smaller and therefore cause much less damage to the cells; (*b*) the freezing period being much shorter, less time is allowed for the diffusion of salts and the separation of water in the form of ice; (*c*) the product is quickly cooled below the temperature at which bacterial, mold, and yeast growth occur, thus preventing decomposition during freezing; and (*d*) the product is quickly cooled to a temperature at which enzyme action is of no practical significance, and the original freshness is thus retained. This quick chilling is of great importance in the case of sweet corn, peas, lima beans, asparagus, strawberries, raspberries, and other fruits and vegetables."

THE IMMERSION PROCESS OF QUICK FREEZING IS DEVELOPED

Previously, very low temperatures had been resorted to in order to get reasonably rapid freezing. The attempt to obtain high-speed freezing, without the use of very low temperatures, led to the immersion process; some aspects of it have been described in earlier publications (14, 15). Mechanically, it involves pumping a continuous stream of the refrigerant solution past the product to be frozen, in direct contact with it. If one dimension of each unit of the commodity is small, as in the case of asparagus or berries, it is frozen in its natural form. Where the minimum dimension is considerably larger, as in the case of peaches, the product may be cut into smaller parts. With either type, the pieces are arranged in a layer, or "curtain," on a support, the design of which is such that it does not greatly impede the flow of the refrigerant solution. As the support carries the product along, the solution flows through it and through the curtain of product at approximately right angles to their plane. The solution is then circulated past suitable refrigeration coils, and returns again to the freezing chamber.

When individual fruits or vegetables are immersed in a circulating solution of relatively low viscosity maintained at a temperature of approximately 5 F, freezing is accomplished in a very few minutes. For example, strawberries of average size are frozen in six minutes, and peas in from 30 to 50 seconds. Yet at no time is the temperature reduced below that at which the frozen products are to be subsequently stored. It has been found that the crystals produced in products so frozen are smaller than those produced by some of the systems of quick freezing which have been used commercially; frequently they are no larger than the individual cells themselves. Hence the cells are not damaged appreciably, and the character of the defrosted products very closely approaches that of the fresh commodities (8). The solution used for strawberries and other small fruits is one containing invert sugar of a strength of approximately 57 Brix. It has a relatively low viscosity at 5 F, and is therefore quite efficient as a medium for heat transfer.

The results obtained on small laboratory equipment indicated the excellence of the commodities which might be frozen by this method, and a larger machine was constructed and installed in an experimental freezing laboratory and pilot plant as shown in Fig. 3. In this way it was possible to find out whether the cost would be low enough to permit profitable operation, and to show whether the process was a feasible one under practical operating conditions. In 1937, 119,000 pounds of strawberries, youngberries, and sliced peaches were processed on this equipment. They were distributed through ordinary market channels, in Cleveland, St. Louis, New York, and Washington, in order to determine consumer acceptance. As a result of high quality, the experimental pack of strawberries in 1937 realized a price premium of some three cents a pound. The income went back to the project, thus reducing the cost of the experimental development. The cost of the freezing operation alone was determined at 0.29 cents per pound. Since the machine was experimental and the plant operated only a short time, a fair allocation of overhead and other fixed charges was impossible. Necessary engineering data were obtained on the problems of operation and of equipment design.

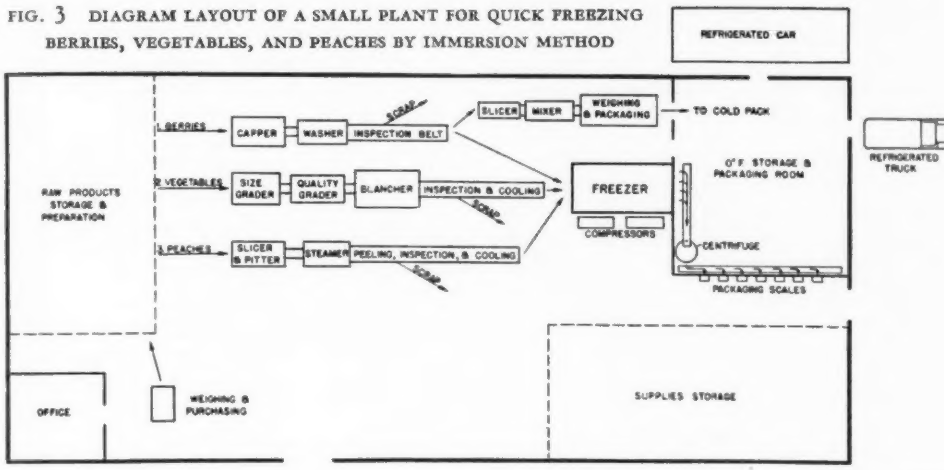
In processing farm crops, the course of least resistance is to arrange for a supply of raw materials as close to the plant as possible. Frequently processors own or rent land which they operate as part of the enterprise, and also contract with a few large growers within a small radius. The disadvantage of this procedure is that any favorable effects upon the existing agriculture are rather narrowly confined.

In the experimental operation just referred to, an effort was made to go as far as practicable in the opposite direction; the crops purchased came from about 100 ordinary farms located in four counties; several were over twenty miles from the plant. In recent years, low prices realized in this area in selling strawberries on the fresh market had resulted in rapid deterioration of the soil. This happened because low prices caused the farmers to try to grow berry crops with absolute minimum cash outlay, without using enough fertilizer to keep the land up, and without "mulching," i.e., covering the plants with

[2] Photograph taken from "Microscopic Studies of Frozen Fruit and Vegetables," by J. G. Woodroof, Bulletin no. 201, Georgia Agricultural Experiment Station, September, 1938.

straw, which protects the fields against erosion. The experience of other areas, which, as a result of freezing operations, had increased the year-round returns which farmers could anticipate, was that abuse of soil was abated. In this connection, it is significant that quick freezing increases the proportion of the total crop that can be used (16). In this development also the same thing occurred. There was a marked improvement in the quality of the raw materials delivered to the plant, which was due to proper care of the fields, better fertilization, and "mulching," as soon as growers visualized more reliable markets for their crops.

FIG. 3 DIAGRAM LAYOUT OF A SMALL PLANT FOR QUICK FREEZING BERRIES, VEGETABLES, AND PEACHES BY IMMERSION METHOD



(Products leaving the freezer are kept temporarily in a small zero storage room, from which they are conveyed to carton packers who work outside this room at ordinary temperatures. Packages are then returned to the zero room for casing and shipping. Oversize and undersize berries are diverted to "cold pack," which is trucked to a commercial zero warehouse for freezing. Materials-handling procedures are practically identical with those in canneries.)

Quick freezing can provide local employment in considerable volume. Operating at 2000 lb per hr on berries, there is ordinarily work for over 1000 girls in capping and inspection. Added to the payments to farmers for crops, the economic gain to an area which processes its crops before shipping them may be considerable. Tennessee strawberries, for instance, have over a period of years left about $4^1/_4$ cents a pound in the area when shipped out in raw product form. If marketed in quick-frozen form, the same crops could leave an income of from 8 to 11 cents per pound in the area, which is more than double.

The experimental operation also included studies of other agricultural problems. Quality depends on freezing technique, but equally important are growing, harvesting, and handling the crops. Much agricultural research remains to be done in the development of even-ripening varieties which give the utmost in freezing perfection, and in adapting them to the soils in particular localities. The farmers depend upon the agricultural experiment stations in their own states as the principal sources of this information. The organizations in two states are coordinating their research with the work of the engineering experiment station of the University of Tennessee, which operated the freezing equipment. Thus the agricultural phases of the program have been correlated with the engineering and economic requirements.

Full cooperation of the farmers is essential. After the agricultural research was finished, there still remained the problem of teaching the farmers to grow the right varieties, pick them at the proper stage of ripeness for freezing, pack them acceptably, and so on. Results in these matters can best be achieved under the leadership of the agricultural extension services; the farmer will ordinarily listen to his county agent, who he knows has no axe to grind, but is generally suspicious of outsiders.

TRANSPORTATION AND STORAGE

Most of the producing areas are beyond the effective service radius of the cold-storage warehouses in the large cities, and relatively small groups of producers would not generally be able to get new zero-storage facilities financed. Hence transportation of the frozen commodities from a small freezing plant to a point of collection presents an important problem.

Very short hauls can be made with ordinary trucking facilities, but the longer hauls require the use of insulated or refrigerated trucks, depending upon time and outside temperature conditions. If a freezing plant of sufficient output should be located on a railroad siding, shipment of the frozen commodities to consuming centers by rail is frequently possible, but the difficulties encountered by this method at its present state of development leave much to be desired. Some of the railroads and refrigerator-car operators are developing greatly improved transportation of frozen foods by rail, and there is no question but that the problem will be solved.

The type of mechanically refrigerated truck used on this project functioned satisfactorily. However, the cost of transportation by trucks within the weight limits permitted on the highways in this part of the country is likely to be high as compared with other methods.

Since the Tennessee river and its tributaries flow through excellent producing areas, the possibilities of water transportation were studied. Most of the fruit and vegetable counties are at some distance from adequate zero storage. Investigation indicated promising results by combining water transportation and storage, the device being a refrigerated barge which could be towed along the river and anchored at points near the producing areas. After being filled, the barge could be towed to any of the large terminal cities on the Mississippi inland waterway system, along which over 22,000,000 people live within 25 miles of its banks. An experimental unit of this type—a traveling zero-storage warehouse—was built and tested. An analysis of the costs, based upon actual shipment of a load of frozen fruit from Chattanooga, Tennessee, to St. Louis, Missouri, in 1938, indicated astonishing economies for this method of combined storage and shipment.

The experience gained as a result of the experiments has made it possible to design a continuous freezing machine which should meet the requirements of simplicity and reliability. The evaporator arrangement is much better than in the first experimental machine (15) shown in Fig. 4, and the feed is such that almost any commodity of reasonable size could be handled, without mechanical adjustments. The design actually made is for 2000 lb of product per hr. Very much larger sizes could be built, and also machines of a quarter this size. Hence, it appears likely that portable machines might be developed, and that portable operation may be practicable, so that the freezing unit may be moved from one small community to another.

The products are carried through the machine by a continu-

ous stainless conveyer, and are then discharged into a semi-automatic centrifuge which removes the excess refrigerating solution. From the centrifuge the products go to the packaging conveyer. The solution is clarified, filtered, and automatically maintained at the proper level of concentration.

A TRIAL IN ACTION

Even in the course of the brief period of operation of the experimental plant, it was observed that some of the anticipated favorable effects upon agriculture had begun to occur. Specifically, most of the approximately 100 cooperating farmers were improving their crops, taking steps which reduced soil erosion, and giving the land better care generally. These things would not have taken place except for the work of the established agricultural extension service in obtaining the cooperation of the farmers, nor without the research guidance of the agricultural experiment station.

There has been, throughout the country, a great deal of very general thought about industry in rural areas and its desirability, but discussion of the principle seldom leads to any practical conclusions; this is because the feasibility of manufacturing can be determined only in specific cases, and in each specific case the determination ordinarily requires thorough research in engineering, in market economics, and frequently in several other fields as well.

In the case of the development herein described, the coordinated research efforts of a number of public agencies seem to have opened a definite opportunity for a new local industry, immersion freezing. It is inherently "decentralized;" there can never be a Detroit of quick freezing, because the processing units must be located very near to the crop production. Due to the enlarging markets, a considerable expansion of quick freezing of perishable crops appears to be inevitable.

If and when the process is used commercially, it would appear to be in the general interest that its introduction take place under circumstances which will insure full correlation with agriculture, and careful observation of the extent to which the much-discussed benefits of industry in rural areas actually occur. The organizations, previously referred to, that are technically familiar with the process and all aspects of the setting, are within reach. They could assist in guiding and watching the entire situation in connection with the early stages of its commercial introduction.

It is hoped that the engineering development of a new process and the necessary machinery may contribute in a very modest way to the enlargement of the body of knowledge and experience available to the nation regarding the important matter of closer coordination of agriculture and industry.

FIG. 4 EXPERIMENTAL FREEZING MACHINE INSTALLED IN PILOT PLANT, BRADLEY COUNTY, TENN.

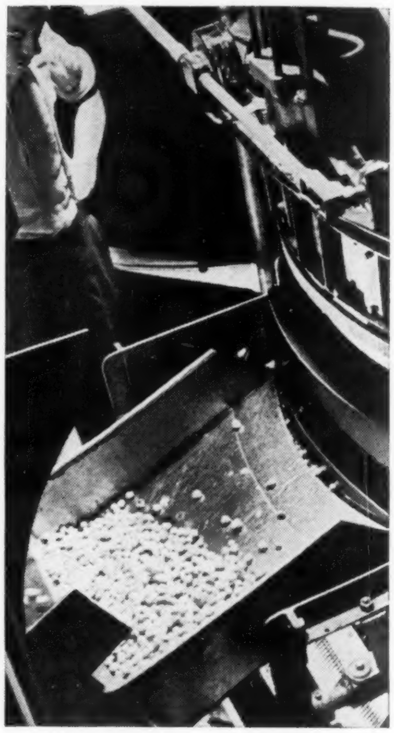


FIG. 5 AUTOMATIC FEED ON EXPERIMENTAL FREEZING MACHINE WHICH IS SHOWN IN FIG. 4

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A NEW-TYPE ORCHARD HEATER

Combustion-Chamber Bowl-Type Orchard Heater Utilizes Inert Diluents

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THE PRACTICE of protecting citrus groves in California against damage from frosts by heating has progressed far since its beginning near the end of the 19th century; but there is still much to be desired from the present orchard heaters and orchard heating practices. Some of the problems and shortcomings of the present orchard heaters and orchard heating practices are discussed in a paper written by F. A. Brooks and published in the September, 1938, issue of MECHANICAL ENGINEERING.

There are many different types of heaters, of which the bowl-type heater is only one, which are used at the present time to heat citrus groves in California. Any heater in which the fuel is evaporated directly from the oil reservoir and burned almost immediately is classed as a bowl-type heater. There are two general classes of bowl-type orchard heaters—the lazy-flame heater in which only part of the combustion of the fuel takes place within the bowl and stack while, probably, over half of the fuel is consumed in the open flame above the top of the stack, and the combustion-chamber heater in which the fuel is burned more or less completely within the heater. The heater shown in partial cross-sectional view in Fig. 1 is a good example of a lazy-flame heater while the heater shown in Fig. 2 is a good example of a combustion-chamber bowl-type orchard heater.

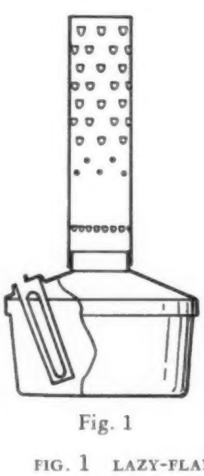


Fig. 1

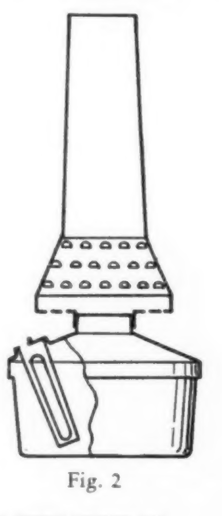


Fig. 2

FIG. 1 LAZY-FLAME HEATER WITH SCHEU NO. 230 STACK

FIG. 2 COMBUSTION-CHAMBER TYPE OF HEATER WITH NATIONAL JUMBO-CONE STACK

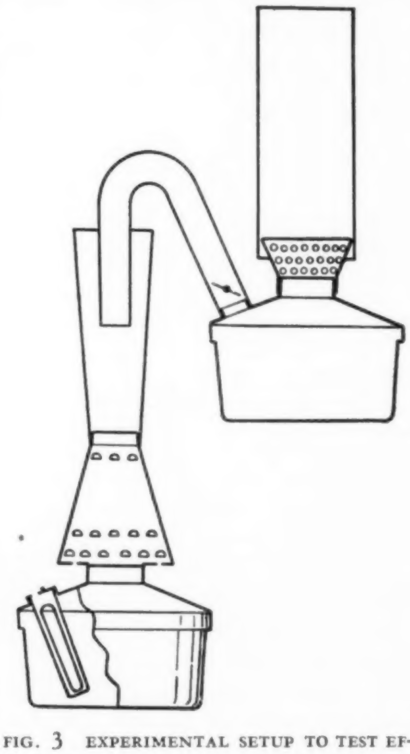


FIG. 3 EXPERIMENTAL SETUP TO TEST EFFECTIVENESS OF USE OF STACK GASES TO REDUCE THE SMOKE OUTPUT OF AN ORCHARD HEATER

This paper is concerned primarily with the bowl-type heater. Although some of the other types should be inherently easier to perfect for the economical heating of orchards, there are over three million bowl-type heaters in the field in California at the present time, and since it is probably the simplest, most dependable, and generally most satisfactory type of heating unit for the small orchardist, there is sufficient justification for the expenditure of considerable time and effort in the further development and improvement of this type of heater.

Contributed by the Fuels Division for presentation at the Semi-Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS to be held in San Francisco, Calif., July 10–15, 1939.

THE USE OF DILUENTS TO REDUCE SMOKE OUTPUT

It is a well-known fact that live steam introduced into the firebox of a coal or oil furnace will tend to reduce the smoke output from the furnace. Also, when certain quantities of live steam are introduced into the bowl of a bowl-type orchard heater the rate of soot accumulation in the bowl and the smoke output from the heater are greatly reduced. The use of steam in the bowl type of orchard heater, however, did not seem economically practical and so was not tried by the author.

The only other relatively inert diluent available for use in these heaters was the gaseous products of combustion from the heaters. It has been known since the beginning of oil burning on a commercial scale that the mixing of part of the flue gases with the incoming air has almost the same effect on the fire as the addition of live steam. This principle offered at least a partial solution to the problem at hand.

PRELIMINARY EXPERIMENTS AND RESULTS

The first experiments that were conducted to determine the effectiveness of the use of stack gases to reduce the smokiness of oil-burning orchard heaters were made with two heaters arranged as shown in Fig. 3. The burning rate of the upper heater could be controlled easily by the butterfly damper in the tube connecting the two heaters. This demonstrated clearly that the burning rate of a heater could be controlled to some extent by the amount of stack gases which were used to dilute the fuel vapors.

It was also found that the composition of the stack gases from the lower heater had a marked effect on the burning rate and smokiness of the upper heater. As the free-oxygen content of the stack gases from the lower heater was reduced the amount of stack gases required to keep the upper heater burning

increased and the smokiness decreased. When the free-oxygen content of the stack gases from the lower heater was reduced to as low a value as could be obtained, the flame in the upper heater became pale blue in color, and was almost nonluminous and absolutely smokeless. During the running of these experiments very little soot was deposited inside the cover and bowl of the upper heater.

These experiments demonstrated definitely the effectiveness of the use of stack gases as a diluent of the fuel vapors for reducing the smokiness and the rate of soot accumulation in the bowl of an orchard heater.

DESIGN AND CONSTRUCTION OF THE HEATER

Obviously the next logical step was the construction of a heater which would use its own stack gases to dilute the fuel vapors. No attempt was made to use a lazy-flame heater because the flame above the top of the stack is so unsteady and easily deflected by even minor disturbances in the surrounding air. Several different combustion-chamber types of heaters were tried, including experimental as well as commercial heaters.

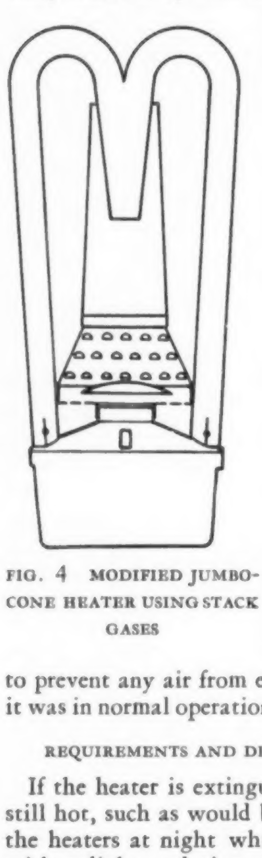


FIG. 4 MODIFIED JUMBO-CONE HEATER USING STACK GASES

Of the various heaters experimented upon, the modified "Jumbo Cone," illustrated in Fig. 4, showed the most promise. It had a flame spreader in the combustion chamber, two pilot-flame nozzles of different sizes located in the cover on opposite sides of the throat, and a double-stack-gas-return system. It was decided to improve and simplify this heater. Fig. 6 is a cross-sectional view of the resulting heater showing some of the construction details and changes to the standard Jumbo-Cone heater. The flame spreader was not used, the stack-gas-return system was reduced to a single 3-in. tube, only one pilot-flame nozzle was used and a tight-fitting metal disk was added to the inside of the filler cap to prevent any air from entering the heater at this point when it was in normal operation.

REQUIREMENTS AND DESIGN OF STACK-GAS-RETURN SYSTEM

If the heater is extinguished and then relighted while it is still hot, such as would be the case if it were necessary to fill the heaters at night while they are burning, it will ignite with a slight explosion which sometimes starts the circulation through the return system in the wrong direction. Under these circumstances, air will enter through the louvers and holes in the burner and pass down through the throat into the bowl where it will support combustion. A large part of the heat thus liberated will evaporate the fuel and consequently the resulting gaseous mixture becomes very rich in fuel vapors. This inflammable mixture passes up through the return tube and is discharged downward into the stack from the entrance end of the return tube. Some of this mixture goes as far down the stack as the burner before it reverses its direction and passes out of the top of the stack. After a few minutes of operation in this manner, the combustion in the bowl becomes more rapid, oscillation in the burning rate sets in, and some of the flame comes out of the bowl into the burner during part of each cycle. After doing this a few times, the flame in the burner generally succeeds in igniting the combustible mixture in the stack. When this happens normal circulation through the burner and stack begins. This circulation builds up enough pressure against the entrance end of the return tube to stop the reverse circulation and start it in the right direction through the return tube. The heater will then continue to operate properly until it burns dry or is extinguished.

Sometimes, when the heater is nearly empty and the fire about ready to go out, it will start to oscillate and, during one of these oscillations which amount to mild explosions, may reverse the circulation through the return system. Under these circumstances, the fire will be low in the bowl and, generally, not reach into the burner. Also, the resulting gaseous mixture passing up the return tube is less inflammable due to the poor quality of the fuel left in the bowl. For these reasons the heater will generally not succeed in reversing the circulation through the return system, but will continue to operate in this manner until it has consumed all of the readily combustible materials left in the bowl.

Whenever the heater is operating in this reverse manner, it gives off large quantities of smoke which contain both soot and large amounts of unburned or partially oxidized hydrocarbons. If the heater is found to be operating in the reverse manner, it can be easily corrected by opening the filler cap for a few seconds. This allows a large quantity of air to enter the bowl and the resulting flame will be so large that some of it will extend far enough up into the burner to ignite the combustible mixture coming out of the entrance end of the return tube. This will start circulation through the burner and stack in the right direction and the heater will resume its normal operation.

Since the gases in the return system are hot and therefore lighter than the surrounding atmosphere, they will tend to flow upward through the return tube, which is, of course, in the wrong direction. For this reason, the stack-gas-return system must be designed to offer a minimum resistance to flow in the right direction. At the same time it should offer a maximum resistance to the flow of gases in the wrong direction, and when the gases are circulating in the wrong direction, it should discharge them in such a way that the heater will go back to normal operation of its own accord in as short a time as possible.

One-piece conductor-pipe elbows were used in the return system to reduce the resistance to flow as much as possible. The entrance end of the return tube was tapered down from 3 in. to $2^1/_2$ in. in diameter because the gases pass up the center of the stack with a considerably higher velocity than through the return tube. They can decelerate in this tapered section without much more loss of pressure than they would suffer from an abrupt deceleration on entering a straight 3-in. cylindrical section. For this reason the tapered section will not appreciably increase the resistance to flow in the right direction. When the flow is in the opposite or wrong direction, this tapered section will make the discharge velocity higher and so increase the discharge loss in the system. This will tend to restrict flow in this direction and cause the inflammable gases to go farther down the stack and into the burner where they will become ignited from the flame in the bowl. Since it is necessary to make this tapered section out of heat-resisting steel, it should be made as short as possible, and yet discharge the gases when circulating in the wrong direction as low in the stack and with as high a downward velocity as possible.

The entrance end of the return system should, if possible, be located in the stack at a point where the stack gases contain a minimum concentration of free oxygen, and where the gas velocity is a maximum, and pointed in such a direction as to make the best use of this velocity to assist in the circulation of gases to the bowl. The arrangement of the air and fuel entrances in the burner of this heater is such that points of minimum free-

oxygen content will be found on the axis of the stack and burner. Also, since the flow up the stack is axial, the maximum gas velocities will be found near the axis of the stack. For these reasons the entrance end of the return tube should be pointed down the stack and should be coaxial with the stack.

REQUIREMENTS AND DESIGN OF PILOT-FLAME NOZZLE

In order to maintain the burning rate of the heater as nearly constant as possible when the oil level goes down, the pilot-flame nozzle was designed to give a flame which would penetrate as deeply as possible into the gaseous mixture above the oil and reach the surface of the fuel even when the bowl was nearly empty. A straight taper was chosen as the simplest type of nozzle to manufacture which would give a jet with good penetrating power.

The design which was finally adopted is shown in Fig. 5. Some of the air which enters the upper end of the nozzle passes through the small holes about halfway down the taper into the annular space between the taper and the outer cylindrical shell. Since the cross-sectional area of this annular space is very large compared with that of the holes, the air velocity in this part of the nozzle is low. A flame can be easily maintained at the tip of this outer part of the nozzle with very little tendency to being blown out even with high air velocities in the central tapered portion of the nozzle. This small annular flame acts as a pilot flame to the central flame and keeps it lighted at all times when it would otherwise be carried away from the tip of the nozzle. This principle and construction are used in the design of many single-port burners which use natural gas.

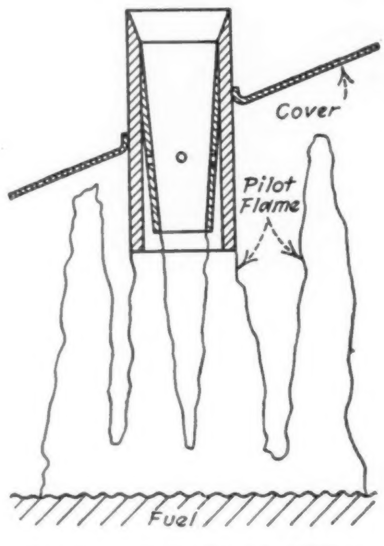


FIG. 5 PILOT FLAME AND NOZZLE

Another feature of the pilot-flame nozzle, as installed in the heater shown in Fig. 6, is the direction in which it is pointed. Observations of the color and behavior of the pilot flame produced by nozzles inclined at various angles to the vertical showed a softer and less sooty flame when the nozzle was pointed vertically downward. With the axis vertical, the pilot flame, after striking the surface of the oil, rose around the tip of the nozzle, more or less completely surrounding the central flame with products of combustion. The fuel vapors which entered into the combustion in the flame were thus diluted with inert products of combustion, thus tending to reduce the smokiness of the pilot flame.

When the nozzle was inclined to the vertical, it was not enveloped in the flame and the pure fuel vapors, being diluted only by the stack gases from the recirculation system, entered into combustion with the air passing through the nozzle which resulted in a very bright but sooty pilot flame. The inside of the cover and bowl accumulated soot more rapidly with this pilot flame than with one produced by a vertical nozzle.

The pilot-flame nozzle was located in the cover about midway between the throat and outside edge and about 60 deg around the cover from the stack-gas-return tube. Its location in the cover is not very important but it was thought that by placing it near where the stack gases entered the cover the pilot flame would be burning in an atmosphere containing a high concentration of stack gases and so would not produce so much soot in the bowl. If it is placed too near the return tube, the stack-gas concentration around the pilot flame may become so high at times that it might extinguish the pilot flame. Also, if it is very close to the return tube, it might soot up its damper and tube end, thus reducing the amount of stack gases returning to the bowl. The flame will also have a tendency to go up the return tube and start the circulation in the wrong direction.

REGULATION OF THE BURNING RATE

The inside diameter of the tip of the pilot-flame nozzle designed for this heater was $^1/_2$ in. Another tapered nozzle, which was designed to be slipped into the $^1/_2$-in. nozzle, had a diameter at the tip of $^{11}/_{32}$ in., which gave burning rates about 20 per cent lower than those obtained with the $^1/_2$-in. pilot-flame nozzle. It was found that the heater could be made to operate fairly satisfactorily with no pilot flame at all. The burning rates under these circumstances were about 40 per cent lower than with the $^1/_2$-in. pilot flame.

A doughnut-type butterfly damper was put in the lower end of the stack-gas-return tube. When this was turned at right angles to the flow of gas, the burning rate was reduced about 20 per cent. A solid butterfly damper was not used as any further reduction in the amount of stack gases returned to the bowl would make the heater smoke.

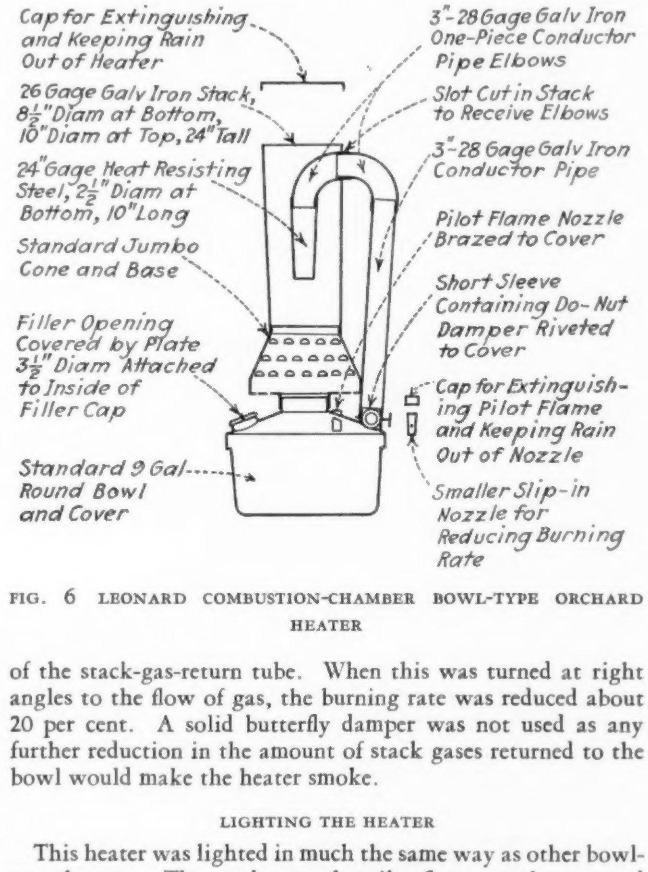


FIG. 6 LEONARD COMBUSTION-CHAMBER BOWL-TYPE ORCHARD HEATER

LIGHTING THE HEATER

This heater was lighted in much the same way as other bowl-type heaters. The stack cap, the pilot-flame nozzle cap, and the filler cap were removed. The burning end of the lighter was then thrust through the filler opening and a small quantity of lighter fluid was allowed to run out onto the surface of the oil and the sides of the bowl above the fuel level. The lighter was then withdrawn and the heater was allowed to warm up. The flame inside the bowl spread rapidly to the whole surface of the oil and, in less than one minute, completely filled the combustion chamber and extended out of the top of the stack. At this point the filler cap was tightly closed, preventing any more air from entering the bowl at this point, and the heater

soon settled down to a steady burning rate. Further experiments with different amounts of fuel in the bowl showed this heater to light just as easily and quickly at all oil levels in the bowl. Like most other bowl-type heaters, this heater was difficult to light when the bowl and cover were new and clean, but after several hours of operation it was always easy to light.

OPERATING CHARACTERISTICS OF THE HEATER

The pilot flame may be accidentally extinguished by strong gusts of wind or it may be blown out when the heater is oscillating during the warming-up period. Under these circumstances, the heat liberated in the bowl and the rate of vaporization of fuel will decrease. This will increase the oxygen content of the stack gases and the oxygen added to the air entering through the nozzle will soon render the mixture in the bowl explosive. The flame will then flash back into the bowl and generally relight the pilot flame. Also, if the heater is operated at a low burning rate with the pilot-flame nozzle capped, and the cap is removed to increase the burning rate, the same condition and results will follow.

The burning rate of this heater, using the oil which was available at the time with the $^1/_2$-in. pilot-flame nozzle, was from 7 to 8 lb per hr with from 6 to 9 gal of oil in the bowl, 6 to 7 lb per hr with 3 to 6 gal in the bowl, and from 5 to 6 lb per hr with less than 3 gal in the bowl. These burning rates were only obtained with fresh oil. When this heater was operated for long periods without burning it dry or emptying it, the heavy ends of the fuel and any heavy compounds formed from the oil during the operation of the heater accumulated in the bowl and reduced the vapor pressure of the oil. This did not noticeably affect the burning rates when the bowl was full but as the oil level went down the burning rates fell off more rapidly than they did when the bowl was initially filled with fresh oil. Even under these circumstances the burning rates did not fall off as rapidly as they did in most other bowl-type heaters with any fixed setting of the regulators. Later tests of this heater with other fuels indicated that the oil used in the earlier tests on this heater was slightly more volatile than most orchard-heater oils and therefore gave slightly higher burning rates than would be obtained with most other orchard-heater oils.

If higher burning rates with low-fuel levels are required, the pilot-flame nozzle will have to be made larger. But, since this heater smokes a little when burning 8 lb of fuel per hour, it would probably smoke badly if a larger pilot-flame nozzle were used and left open when the fuel level was high in the bowl.

It was found that certain oils were very susceptible to oxidation and polymerization at the temperatures developed in the bowl of this heater. When burning these oils in this heater, objectionable quantities of heavy resins and tars would accumulate in the bowl, especially when the heater was operated at low burning rates for long periods. Other oils did not show this effect. Experiments are being conducted at the present time to develop laboratory tests which will differentiate between oils having different susceptibilities to oxidation and polymerization at elevated temperatures. It is hoped that these tests will be dependable enough to enable operators of this type of heater to select only fuels which will function satisfactorily in the heater.

CONCLUSIONS

1 The use of stack gases to dilute the fuel vapors in the bowl of a bowl-type orchard heater is entirely practical, greatly reduces the rate of soot accumulation in the bowl, and gives the heater a much wider range of burning rates with smokeless operation.

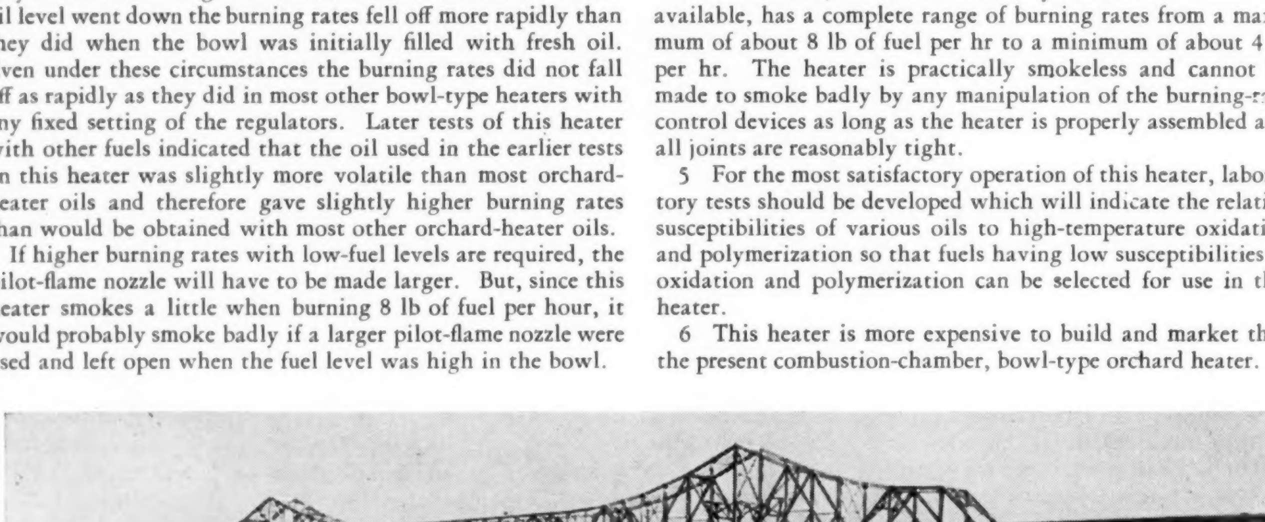
2 The stack-gas-return system must be designed so as to offer a minimum resistance to the flow of gases in the right direction and, at the same time, a maximum resistance to flow in the wrong direction, and be able to reverse that flow by itself if it should at any time get started in the wrong direction.

3 The pilot-flame nozzle and resulting flame, as designed for this heater, produces much less soot in the bowl and gives a more uniform burning rate as the fuel level in the bowl goes down than the conventional regulator and downdraft tube installed in the present bowl-type orchard heaters.

4 This heater, with the bowl nearly full of the oil that was available, has a complete range of burning rates from a maximum of about 8 lb of fuel per hr to a minimum of about 4 lb per hr. The heater is practically smokeless and cannot be made to smoke badly by any manipulation of the burning-rate control devices as long as the heater is properly assembled and all joints are reasonably tight.

5 For the most satisfactory operation of this heater, laboratory tests should be developed which will indicate the relative susceptibilities of various oils to high-temperature oxidation and polymerization so that fuels having low susceptibilities to oxidation and polymerization can be selected for use in this heater.

6 This heater is more expensive to build and market than the present combustion-chamber, bowl-type orchard heater.



PAN-AMERICAN AIRCRAFT IN SAN FRANCISCO BAY

(Photograph taken by P. R. Sandwell on Treasure Island, where Engineers' Day will be held during A.S.M.E. Semi-Annual Meeting. See pages 479–481 of this issue.)

THE PELTON WATER WHEEL

I—Developments by Pelton and Others Prior to 1880

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IN APPROACHING a historical study of the Pelton water wheel, we may naturally ask, What is the Pelton water wheel? Is it a wheel carrying the form of bucket covered by Pelton's patent claims, or is it more broadly a wheel of the so-called impulse type? But this again raises the question of what is meant by a wheel of the impulse type and of the distinction between this type and the so-called reaction type. An impulse, as defined in mechanics, is the product of a force by a small interval of time. As such it has no very clear application to the definition of a particular type of water wheel.

A water wheel, in essence, is a device for transforming fluid (water) energy into mechanical work. Fluid energy may exist under two forms, pressure (potential) and velocity (kinetic).

In wheels of the Pelton or so-called impulse type, the energy, first in the potential form (pressure head in the reservoir) is next converted wholly into the kinetic form (velocity) by way of a free jet within which the pressure must be that of the atmosphere in which the jet is moving. From this point on, the actual energy transfer to the wheel is wholly by way of reaction, i.e., the development of a pressure on the vanes or buckets of the wheel through a change in the momentum of the stream (change in the direction of flow relative to the bucket) as a result of which the bucket yields under the pressure and moves against the resistance of the load. As a result of the composition of relative velocities, the velocity of the stream relative to the earth is thus reduced, with a corresponding transfer of energy from the stream to the wheel, and useful work is performed. If, therefore, there is any one word which best describes the performance of such a water wheel beyond the point of formation of a free jet, it is reaction rather than impulse.

On the other hand, with the so-called reaction wheel there is no formation of a free jet. The energy of the fluid appears at the wheel partly as kinetic (velocity of approach) but chiefly as pressure. The action is then partly by way of direct unbalanced pressure and partly by way of a transfer of pressure energy into kinetic (increased velocity of flow) accompanied by a change in momentum (change in direction of flow relative to the earth) with the resultant development of pressure on the vanes of the wheel by way of reaction. Under the resultant pressure thus developed, the vanes move away against the resistance of the load, with decreasing pressure in the water and, ultimately, with decreasing velocity of flow relative to the earth (composition of relative velocities). All of this results in a transfer of energy from the stream to the wheel. The action here may, therefore, be termed by way of both pressure and reaction.

It results that the one distinguishing feature between the two types of wheel is that, with a free jet, the action beyond the jet is wholly by way of reaction while with the so-called reaction type, it is partly by way of pressure and partly by way of reaction. In the free-jet type, the transformation of the energy into kinetic form is complete in the jet and from that point on, it is only a matter of transforming this into useful work by way of the utilization of the reactive pressure resulting from a change in the momentum of the stream, and ending finally in the reduction of the stream velocity relative to the earth to some small value sufficient to secure its escape from the wheel.

It would appear, therefore, that the presence or absence of a free jet is, after all, the feature which serves to distinguish between these two general types of water wheel. However, as we shall see, it was the Pelton patents and the improvements based upon them, which have produced the modern commercially successful form of the free-jet water wheel. The name Pelton wheel or Pelton water wheel may, therefore be properly used to cover broadly, modern commercial forms of such wheel, tracing back historically, as they do, to the hurdy-gurdy of early California mining days from which a continued evolution, starting with Pelton and his first patent, leads down to the refined forms and impressive installations of modern times.

It is clear that the total energy of the jet of the Pelton wheel, as it leaves the nozzle, is later partitioned under three items:

1 Useful work represented by the part of the energy transferred to the wheel.

2 Kinetic energy of free translation represented by the residual velocity of the stream after leaving the bucket.

3 Kinetic energy of vortex motion and mixed turbulence.

Items 2 and 3 represent loss beyond recovery. Item 1 represents the useful result and the efficiency is of course represented by the ratio of item 1 to the sum of all three items.

It will then be clear that the efficiency of transformation of water into useful work, in any type or form of water wheel, will be greater as these losses are less, specifically as the residual velocity of the water relative to the earth is less, and likewise as the transformation of direct-flow energy into vortex motion, eddies, whirls, and general turbulence is less. Practically, and with specific application to the Pelton type, this means the reduction of the discharge velocity of flow relative to the earth to the lowest practicable value; and this means, as nearly as possible, a complete reversal in the direction of flow with such relative velocities of stream and bucket as to leave the stream with the minimum final velocity relative to the earth, consistent with its escape from the bucket without interference with the next bucket in order. It means further, that the form of the bucket should be such as to avoid abrupt changes in direction due to angles or sudden changes in curvature, and in particular any change in which the form of the guiding surface falls abruptly away, so to speak, from the direction of stream flow, thus endangering a separation of the flow from the surface with the inevitable formation of turbulence. It means also smooth surfaces and the reduction of skin friction to a minimum.

If the jet were a mathematical line, it would be relatively easy to meet these requirements, at least in high degree. Actually, however, the jet is a cylindrical body several inches in diameter, and the conditions which approach the ideal for one part of the jet will not be equally good for another. Or, put otherwise, a form of bucket surface which would approach the

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ideal for a filament of jet flow, say along its center line, would not suit equally well, filaments of the jet near the circumference. In consequence, the best that can be expected is a compromise between these conflicting requirements, in which, however, the principles outlined must always serve as the major guide. With these principles held clearly in view, it will be easy to appreciate the gradual steps by which the earlier forms of "impulse" wheels and in particular the early relatively crude Pelton forms have been transformed into the highly efficient forms of the present time.

With this by way of an introductory statement of general principles, it will be of interest to gain some idea of the character of the engineering work which prevailed in the mountains of California at the time when the ideas expressed by the Pelton and other similar patents began to take form.

Following the discovery of gold in the mountains of California in the middle years of the last century, the principal interests were naturally those connected, either directly or indirectly, with the mining industry. Thus in the field there were mining operations direct, either by shafts and drifts or by hydraulic methods; there were logging operations and saw mills; there were blacksmith shops, stamp mills, and crushers, with foundries and machine shops in the adjacent valley towns. During the decades 1870–1880 and 1880–1890 these interests had grown to a very considerable magnitude and the various activities covered many fields of industry. Thus hydraulic mining required sources of water under pressure and this meant dams, pipe lines, piping, and hydraulic nozzles (giants as they were termed). Shaft and tunnel mining required not only mining equipment direct for drilling and blasting, but mine hoists and mine pumps; and for these, water power was the most available source. Saw mills also required power and so also did stamp mills and crushers. Water under pressure was, so to speak, to be had for the asking. It was the most available source of power and in these mountainous regions, high head with relatively small volume was naturally the rule.

These conditions called for the use of a form of water wheel entirely distinct from the more familiar overshot and undershot types, where the heads were less and the quantities of water greater. Under the conditions in the California mountains, the use of some form of free-jet wheel was inevitable. The primitive form which it seems to have taken and which these early inventors had more or less in common as a starting point for their efforts toward improvement, was the so-called hurdy-gurdy. This seems to have been an independent development in these mountains, a natural outgrowth of the environment and of the materials most conveniently at hand. Furthermore, though crude and relatively inefficient, it was easily made up of timber, of which there was an abundant supply, and it can at least claim the credit of having served as the starting point for the more special developments which led to the later improved forms.

The hurdy-gurdy wheel was made up of wood blocks usually about four inches thick, cut in the form of the teeth of a circular saw (ripsaw teeth with front face nearly radial). These teeth, arranged around the circle, were then closed in on each side by wood casings forming the sides of the wheel, with V-formed cavities between. To the sides of the wheel were then fitted four spokes or arms which at the center of the wheel were mortised into a wooden shaft fitted with round gudgeons as journals. These gudgeons, carried in suitable bearings usually gouged out of live oak, completed the wheel proper except for some form of pulley or drum carried by the shaft, according to the particular use contemplated. In the cruder forms, the water was applied to the wheel in the form of a jet spouting through a hole bored through a wooden block closing the end of the pipe line. The pipe line itself was sometimes of wood and sometimes of sheet iron. With heads not exceeding fifty feet, square wooden conduits were frequently used with iron bolt fastenings, if such could be obtained; otherwise wood frames, cleats, and wedges were used.

Water wheels of this type were common in the fifties of the last century where power units of relatively small capacity were required. As time passed, however, it was found that, by the use of somewhat higher heads and tapered brass nozzles, the sphere of usefulness of such wheels could be extended considerably, and especially to the running of small stamp mills. The question of efficiency was given but small consideration. The main requirement was for a wheel "to do the work" without much regard for the input energy required. With increase in the size of the stamp mills, however, it was found that these hurdy-gurdy wheels were no longer adequate for the power demand. There was a general feeling that this was due to the fact that, with the buckets closed in as they were on each side and terminating in a sharp V-notch at the bottom, there was no opportunity for a free discharge of water from the bucket which, in consequence, remained practically filled with dead water during the period of its contact with the jet, while the latter, in consequence, acted simply on the water with which the bucket was already filled, sliding over its face rather than penetrating into the bucket.

This explanation had some foundation in the mechanics of operation of the wheel, but it was hardly a complete analysis of the situation. There was no approach to a reversal of the stream with the water retaining only sufficient residual velocity to secure discharge from the bucket; the form of the bucket was composed of plane surfaces meeting at sharp angles and the surfaces themselves, presumably, were none too smooth. The main causes of inefficiency were failure to reduce the residual velocity of the water by more than a moderate fraction of its original value, jointly with the transformation of a considerable fraction of the energy of the jet into vortex and eddy motion, resulting in mixed turbulence as against linear flow. In brief, there was too much energy lost in the terminal velocity of the water relative to the earth, and in eddies and fluid friction. Against this handicap, the resultant efficiency of these wheels was said to have been about 40 per cent.

With the ever-insistent demand for larger units and more power, it is not surprising that the millwrights of the day, and others in contact with the prevailing conditions, should have turned their attention to the problem of improving this rather crude hurdy-gurdy wheel. The millwrights of those days discharged the function of the engineer in more recent times. They were living with the problem. The demands of the day called for something simple, strong, and durable; something which could be transported up steep mountain trails and assembled in place, or else built on the spot as was the hurdy-gurdy; something within the skill of the ordinary mechanic for operation and maintenance. In short, something with the simplicity and rugged character of the hurdy-hurdy but with increased capacity and improved efficiency.

It is impossible at the present time to know the extent to which the basic theory of the water wheel was understood by the millwrights and inventors of the California foothill and mountain districts in those days, or the extent to which they may have been conversant with what may be termed the "prior art." It seems safe to assume that their acquaintance with the prior art must have been quite limited in scope. In order, however, to gain a better present picture of the development which grew out of this hurdy-gurdy wheel, it will be desirable to review briefly the prior art with wheels of this general type.

The use of a motor actuated by a free fluid jet certainly goes back to Branca in 1629. Such a device was used in Loretta,

Italy, and is pictured as a horizontal wheel with vanes or buckets upon which a jet of steam impinged, causing rotation.

Euler, in 1754, in his description of the first-constructed turbine, considered the flow of water in a semicircular path, thus apparently contemplating a complete reversal in the direction of flow.

Borda, in his memoirs (1767), stated the underlying principle of a free-jet fluid motor in these words:

> To produce its total mechanical effects, the water serving as a motive power must be brought onto the wheel with impulse and leave it without velocity.

Just what Borda meant by "with impulse" may not be quite clear, but presumably he meant to imply that, forced by the form of the vane or bucket to change its direction of flow relative to the earth, the resulting change in momentum would give a force in the direction of rotation of the wheel. In any event, it is evident that he understood clearly the requirement that the water should leave "without velocity" (relative to the earth), thus implying a complete transfer of its energy to the mechanical work of turning the wheel.

Navier in 1819 referred to the mills of Provence and Dauphiny as driven by water wheels with spoon-shaped buckets, to which the water was usually led through inclined troughs. And Navier writes:

> The necessity of disposing the machines in such wise that there should be no shock, although established long ago, both by theory and practice, is not so generally recognized as could be desired.

Again in 1827, some two hundred years after Branca, Poncelet demonstrated the inefficiency of flat vanes and substituted therefor, curved forms with the entering edge tangent to the stream, so that the fluid would act on the wheel through most of its course over the concave bucket surface. This form of bucket implied again recognition of the principle laid down by Navier regarding the avoidance of shock through the tangential approach of the jet to the entering edge of the bucket.

A little later in 1843 in Paris, Madame de Girard, brought out a semicircular form of bucket which has become widely known as the distinguishing feature of the Girard water wheel.

Still other examples may be found of water wheels approaching more or less closely the free-jet type, showing that as early as the middle of the last century, there had already developed a very considerable body of "prior art." Passing on, however, to periods within which the demands of the mining industry in California were outgrowing the crude and inefficient hurdy-gurdy type of water wheel, we find an active exhibition of inventive genius directed toward the improvement of this type of wheel, not only in California, but throughout the whole United States.

Reference may first be made to the patent taken out by Jearum Atkins of Washington, D. C., which was issued August 10, 1875. There seems, however, to be some reason for believing that the ideas covered by this patent dated back several years earlier than the patent itself, and if so they may reach back toward the middle of the last century. The drawings and specifications disclose two major ideas:

> 1 A wheel with semicircular vanes or waterways, with the water being applied to these vanes simultaneously from a trunk surrounding the wheel.
>
> 2 A wheel in which the vanes or waterways should move with half the velocity of the entering jet.

In his specification he says:

> I will make the further statement that the velocity of the wheel, in order to obtain the maximum amount of power . . . . . . must equal one-half the velocity of the water at the instant of contact with the buckets.

This statement embodies the principle laid down at least a hundred years earlier by Euler and Borda, but includes also a definite statement of the velocity relations between wheel and water required to realize the end desired.

Since the water, in Atkins' design, was intended to enter the vanes from a trunk surrounding the runner (much as with the modern turbine) there was no formation of a free jet in advance of the contact of the water with the wheel as in the Pelton form. However, the form of the vane or water passage proposed by Atkins closely resembles in action forms employed on wheels of the free-jet type. In fact it will be clear that the path of the water in Atkins' wheel is quite similar to that followed by a free jet impinging at the side of a semicylindrical bucket and thence following around the circular path imposed by the form of the bucket.

It does not appear that Atkins ever himself built a wheel embodying these forms and principles. His design differed, moreover, in form from the later developments along what may be called the Pelton line. Nevertheless it embodied certain basic principles which must govern in the design and operation of such wheels, viz., that the approach of the water to the vane or bucket should be tangential to the vane or bucket surface; that the peripheral velocity of the wheel should be approximately one half that of the jet; that the direction of flow of the stream relative to the earth should be reversed so that the water may leave the wheel without velocity and thus transfer all of its energy to the wheel.

Passing now to the line of evolution which has led more directly to the modern Pelton type of wheel, it appears that the activities which initiated the transformation of the humble hurdy-gurdy into its modern representatives were centered in Amador and Calaveras counties in California. About 1866 the Pacific Iron Works of San Francisco made a cast-iron wheel of an improved hurdy-gurdy type as the drive for a 16-stamp mill at the Gwin mine in Calaveras County. This was the first wheel to embody a material change in design as compared with the older wooden models. The buckets in this wheel were given a center discharge curved in direction so that after the water had spent its first attack on the bucket proper, it could be diverted and thus give, by reaction, a further useful effect.

The change proved beneficial in high degree and the success of this wheel as compared with the cruder hurdy-gurdy forms, proved a turning point in the design and construction of wheels of this type. The old wooden hurdy-gurdy was recognized as a back number; something better was demanded, and new and improved forms in variety soon began to appear.

Apparently the first significant advance in California itself, affecting the development of water wheels of this type, was a form of bucket invented by S. N. Knight of Sutter Creek, California, who, in 1870, brought out the cup-shaped bucket, acted on by a jet of rectangular cross section. In estimating the significance of this form of bucket for a free-jet water wheel, it must be remembered that in all probability Knight knew nothing of the earlier spoon-shaped buckets in France as described by Navier in 1819, or of other like forms. Knight had before him the practice of the day in the mountains of California which at that time was represented simply by the hurdy-gurdy wheel. An interesting picture of these days is given by Knight's own statement concerning the early history of his invention. This is as follows:

> About 1870, I, in common with others, made waterwheels entirely out of wood. The buckets were shaped like saw-teeth, and wooden flanges covered the sides of the buckets, to confine the water; a round nozzle was used; and the general results were considered at that time highly satisfactory. The next step, about two years later, was to make a wooden wheel with iron buckets, giving them a curve and discharging the water toward the center of the wheel—still using, however, the round nozzle.

Two years later than this, Nicholas J. Colman patented a wheel

which had a bucket shaped very much like the present Pelton bucket; the stream splitting and curving off to each side. He, for lack of means, I understand, did nothing with it.

After two or three years more had passed, I made an improvement by using a curved iron bucket and having the discharge towards the center and to one side, much the same as the Collins (Pacific Ironworks) wheel, still using the round nozzle.

After continued experiments with the nozzle, Collins found it did not fill the general requirements; he could not cover enough bucket space along the periphery of the wheel, without covering an equal space in the width of the bucket, by increasing the diameter of the round nozzle.

This induced him to try an elliptical or oblong nozzle; and the first wheel of this character was placed in the Lamphear mine, at Mokelumne Hill, and it was quickly followed by two others, so satisfactorily did they work.

From these wheels sprang the present Knight water wheel; for here it was that I conceived the idea of abandoning entirely any direct modification of the round nozzle, and made the opening a narrow rectangular slit.

The round nozzle did well enough where small quantities of water were used; but upon using considerable water, the nozzle became so large that, while the upper edge could be brought near the wheel the lower edge was far away, and it reduced the power materially, so the slit was determined upon. More than one nozzle was also tried, but it did not prove satisfactory.

In 1875 the first wheel of the present style was placed in the Lincoln mine, at Sutter Creek, and from that time various improvements have been made in the size and arrangement of the slits in the nozzle and shape of the buckets.

Fig. 1 shows the patent drawing of the Knight bucket and wheel.

In order the better to appreciate the developments of the next few years, it will be desirable, at this point, to pass over temporarily the events of these years, and to refer next briefly to Pelton and Pelton's first patent. Introductory to this phase of our study it may be noted that the history of the development of the Pelton water wheel since the original Pelton patent in 1880 is plainly enough set forth in the various patents which have been issued since that time. But what is far more interesting, the genesis of the idea previous to this first patent, how much of it was due to Pelton himself and how much was perhaps due to others or was, so to speak, "in the air;" these are matters which are far less clear.

Reference has already been made to the character of the demands made by the mining industry of early California on the engineering practice of the day, and on the millwrights and mechanics which were its chief exponents in the field. Out of this background of pioneer mining engineering (presumably sometime in the fall of 1880) there appeared, early one morning, at the doors of the machine shop of Rankine, Brayton and Company in San Francisco, a man who introduced himself to W. G. Dodd, foreman of the shop, as Lester A. Pelton, a millwright from the mining sections of Nevada City, California. Pelton stated that he had an idea about a water wheel which he wished to talk over with someone, at the same time showing Dodd a model of his wheel bucket.

The story of this visit of Pelton to San Francisco and of the results which immediately followed has come to the present writer from Wm. A. Doble of San Francisco who himself received them from Mr. Dodd direct.

As the story goes, Dodd was immediately impressed with the form of Pelton's bucket, considering it a distinct improvement over the forms then in common use, and seeing the possibility of the development of a good business with the wheel. He accordingly had Pelton wait till Mr. Brayton, general manager of the company, arrived at the shop, to show him the model and point out its advantages.

As a result of some side talk between Brayton and Dodd, there appears to have been an understanding by the latter, that Brayton would interview Pelton and make arrangements to obtain control of his patent, either by purchase or by license, whereupon Brayton and Dodd together would go into the business of manufacturing wheels under this patent. As it developed, however, Brayton seems to have made the arrangements with Pelton in his own name, following which, he, with his son, organized the Pelton Water Wheel Company and proceeded with the manufacture of the wheels under this patent which bore the date of October 26, 1880.

At the start, this company had the wheels made by contract

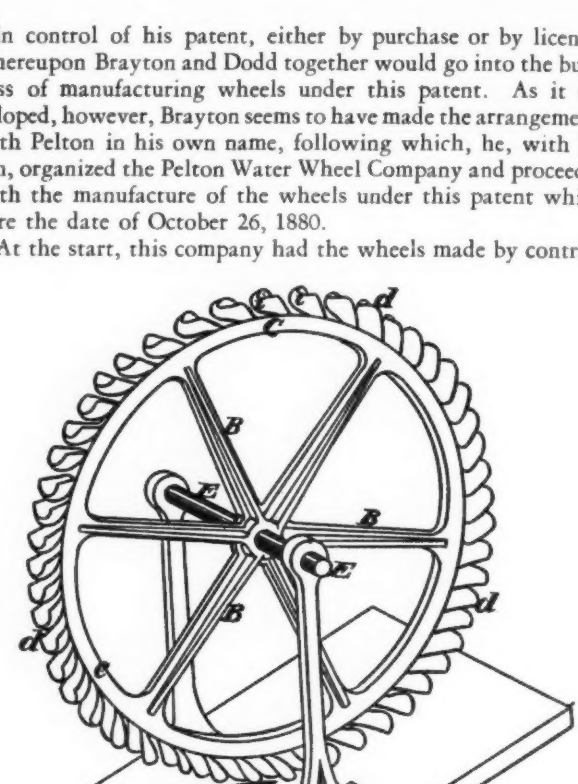


FIG. 1 KNIGHT BUCKET AND WHEEL

in the shops of Rankine, Brayton and Company. This, however, soon proved unsatisfactory and the Pelton Company then opened up a machine shop for the manufacture of the wheels direct.

In the meantime, Dodd, who had felt himself unfairly dealt with in the matter of the arrangements with Pelton, started in to develop a water wheel of his own design. This resulted in his invention of a form of bucket on which he received a patent under date of April 16, 1889. In applying for this patent, however, the Patent Office cited against him a patent to Nicholas J. Colman (referred to previously in the statement of S. N. Knight) issued under date of February 18, 1873, thus antedating the Pelton patent. On receipt of a copy of the Colman patent, Dodd's attorney recognized that certain of the claims of this patent were infringed by the wheels made under the Pelton patent.

Accordingly, as a shrewd move, Dodd went to visit Colman at his home and succeeded in buying outright the Colman patent for a nominal sum of about $500. In this strategic position, Dodd then notified the Pelton people that he had purchased the Colman patent and that the Pelton wheels as manufactured by them under the Pelton patent were an infringement on this earlier Colman patent. This resulted ultimately in the purchase, at a very substantial sum, of the Dodd and Colman patents by the Pelton Co. The final settlement, included as

well, Dodd's water-wheel business and royalties for past infringements.

We may next take note of the claims covered by Pelton's patent and then return to the period of the early seventies. Pelton's patent shows but a single claim reading as follows:

In a water-wheel, the buckets having the curved bottoms *c*, meeting at the apex *d*, and continued to form the inclined discharge sides *e*, in combination with the bucket-front *b*, standing at an incline with the wheel-face, so that the stream from the nozzle shall be received into the bucket without striking its face, substantially as herein described.

Accompanying the specification of the patent are the diagrams as shown in Fig. 2. Referring to the specifications, drawings, and claim, it is clear that the patent was intended to cover the following features: (1) Buckets with curved bottoms; (2) a splitter for the jet (apex *d*) dividing it into two parts right and left; (3) inclined discharge sides *e;* (4) a bucket front *b* standing at such angle with the wheel face as to allow tangential stream flow on and into the bucket.

In closing this description of the bucket and of its operation, he says:

The form of the buckets may be varied somewhat to obtain the best results; but the essential features of the two part bucket with the dividing apex, the curved bottom and the flaring discharge sides will not be altered.

Nothing specific is said in the specifications regarding a complete reversal of the flow of the stream or of reducing its final velocity to zero (or as nearly so as possible) by a suitable relation between the velocity of the jet and the velocity of the wheel. It seems reasonable, however, to assume that Pelton, at this time, had a fair understanding of these matters, and that they were implied in the general background of his patent specifications. With this understanding, it is clear that the Pelton patent represents a water wheel embodying, in substance, the basic elements which have permitted its later improvement in detail to the modern highly efficient forms.

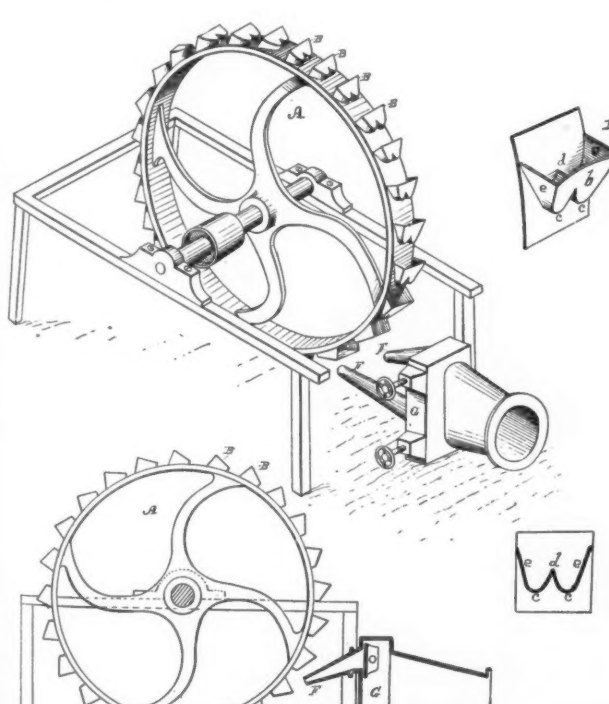


FIG. 2 DRAWINGS OF THE PELTON PATENT

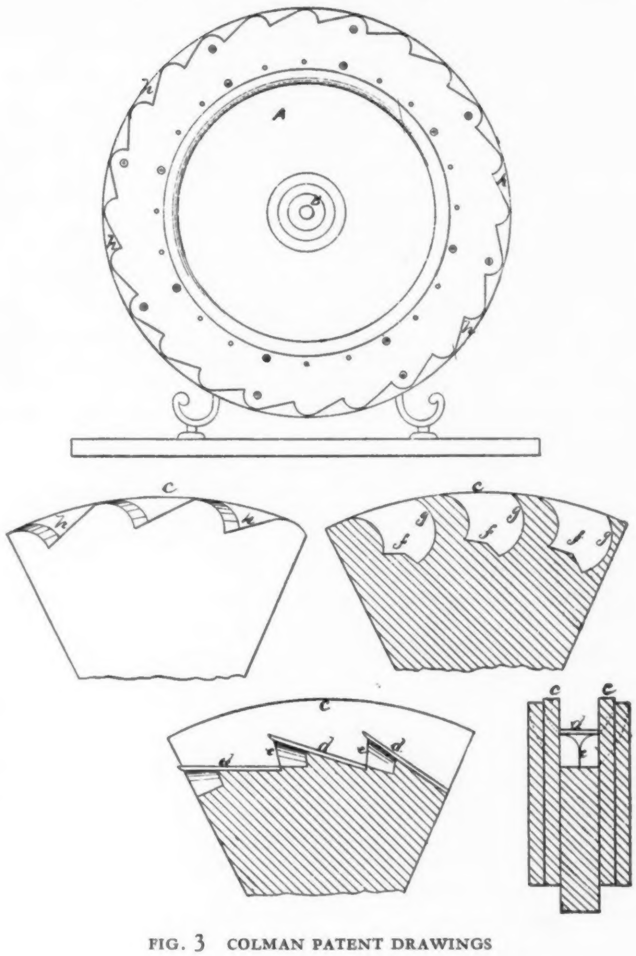


FIG. 3 COLMAN PATENT DRAWINGS

The splitter in the Pelton type of wheel (apex *d*) has always been considered an essential feature of his patent; a feature retained in all later improvements. It is, therefore, of special interest to inquire whether he was the first to incorporate this feature into the design and construction of a free-jet water-wheel bucket, or whether the idea may be found embodied in earlier forms. Reference has been made to the Colman patents of 1873, and to the apparent admission by the Pelton Water Wheel Co. (by the purchase of this patent and by the payment of royalties for past infringement) that certain features of the Pelton construction were an infringement of this earlier patent. This form of water wheel was invented by Nicholas J. Colman of Railroad Flat, Calaveras County, California, and his patent bears the date of February 18, 1873. The specifications of this patent describe a free-jet type of wheel built somewhat along hurdy-gurdy lines.

His description of the bucket and of the action of the water on it states:

. . . . . and this is effected mainly by an improved form of bucket, in which a series of central buckets having wedge or plow shaped points are combined with two series of buckets which are curved outwardly from the central ones, and also upwardly toward the periphery of the wheel where they discharge to the right and left.

The application is accompanied by drawings of which Fig. 3 is a partial reproduction. The idea of the splitter is plainly shown at the lower right, the function of which is, as implied, to split the jet into two equal parts, and then divert these to the right and left through the curved passages (shown rather indistinctly by dotted lines) leading out to the sides of the wheel at the periphery.

The two claims of the Colman patent read as follows:

1 The wedge or plow-shaped buckets, dividing the water at *e*, and curving toward the sides at *f*, substantially as and for the purpose described.

2 In combination with the wedge-shaped buckets, as shown, the upwardly-curving buckets *g* discharging at the periphery, substantially as and for the purpose herein described.

According to the statement by S. N. Knight, previously quoted, Mr. Colman had made, in the early 70's, a form of bucket for splitting the stream; but so far as he (Knight) knew, none of the Colman wheels were ever put into actual use. While, therefore, the idea of the splitter appears to be clearly covered by the Colman patent, it would appear that wheels made under this patent were never brought before the public, nor does this patent appear to have had any specific influence on the later developments represented by the Pelton type of construction.

Shortly following this, Joseph Moore of the Risdon Iron and Locomotive Works, San Francisco, and Prof. F. G. Hesse of the University of California in Berkeley, jointly developed a form of bucket for a wheel which seems, in general form and principle of operation, to have anticipated the Pelton bucket, including in particular the function of the splitter. In February of 1897, Mr. Moore issued a monograph of considerable length in which he claims to be the inventor of the then so-called "California tangential water wheel with reaction buckets." From 1860 to 1880 Mr. Moore was manager, constructing engineer, director, and part owner of the Risdon Iron Works, the records of which give conclusive evidence as to the accuracy of the statements of fact in his monograph. In brief, his statement is that, in 1874, Mr. G. Tiscornia of San Andreas, Calaveras County, California, applied to the Risdon Iron Works for information regarding a water wheel to drive a quartz mill. Mr. Moore, after making a computation based on the water and head available, concluded that it would be impracticable to meet the requirements with the hurdy-gurdy wheels then commonly used, and in view of which he "suggested to Mr. Tiscornia a change of buckets so as to gain reactive effects, also avoid oblique impingements." He further stated that he would send to Mr. Tiscornia a sketch of the form of bucket proposed. "After some correspondence on the subject," continues Mr. Moore, "I made, on March 29, 1874, on an order blank of the Risdon Iron Works, the sketch," herewith reproduced in Fig. 4. On the opposite side of the sheet containing the sketch, Mr. Moore wrote to Mr. Tiscornia, under date of March 29, 1874, as follows:

FIG. 4 COPY OF MOORE'S ORIGINAL SKETCH

You can see the principle (of the wheel), viz.: to receive the water without shock, at an angle of about 10 degrees, and deliver it at the same, or say 15 degrees. This reaction water will have no velocity when at proper speed, but will probably react or spout in the opposite direction; really, its best speed is when it drops straight down, but practically it is best to leave enough velocity in it to clear the wheel.

On March 30, 1874, Mr. Moore wrote again to Mr. Tiscornia as follows:

Yours of the 26th just came to hand. Last night I mailed you a sketch of a bucket which I think is quite superior to the one you sketched. It has the same advantages that you expect with yours; that is, reverses the direction of the water without shock, which is all that can be accomplished by any bucket; but mine has the further advantage of getting rid of the water without its coming in contact with the next bucket, which is a decided advantage, as you see that the water has become stationary with respect to the wheel, or what is more likely, has got a backward motion; then the following bucket must impart the velocity of the wheel to the water again, which is just the same as an overshot

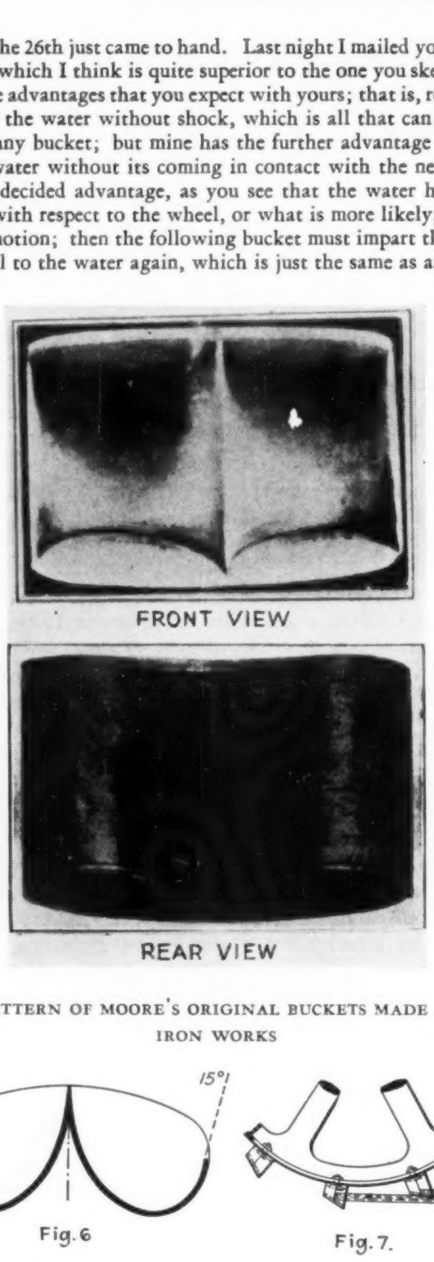
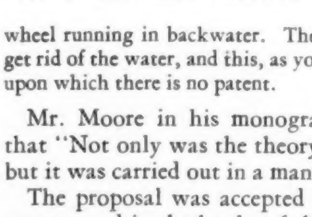


FIG. 5 PATTERN OF MOORE'S ORIGINAL BUCKETS MADE BY RISDON IRON WORKS



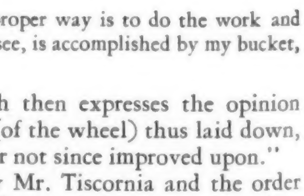


FIG. 6 TRANSVERSE SECTION OF MOORE'S BUCKET

FIG. 7 MANNER OF MOUNTING THE BUCKETS, MOORE'S WHEEL

wheel running in backwater. The proper way is to do the work and get rid of the water, and this, as you see, is accomplished by my bucket, upon which there is no patent.

Mr. Moore in his monograph then expresses the opinion that "Not only was the theory (of the wheel) thus laid down, but it was carried out in a manner not since improved upon."

The proposal was accepted by Mr. Tiscornia and the order was entered in the books of the Risdon Iron Works under date of April 7, 1874 for:

A set of hurdy-gurdy wheel buckets as per pattern and sketch.

The buckets were finished and shipped to Mr. Tiscornia on April 13, 1874, and on the same day Mr. Moore wrote him, saying among other things:

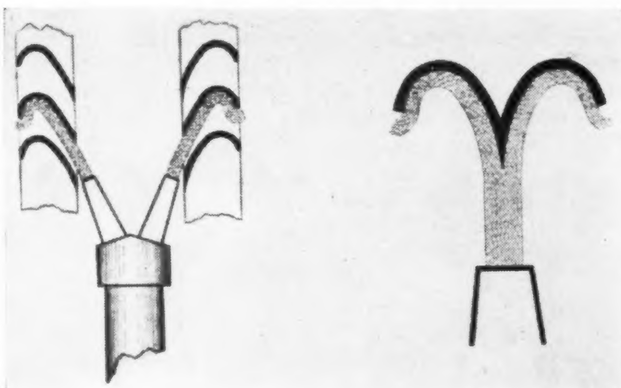
You will find, if you let the water play upon the center, that it shoots back with sufficient clearance to free the following bucket . . . These buckets ought to be 7 to 9 inches apart and the water led on the wheel

at an angle not more than 15 degrees, and from a good nozzle, as close up as possible to the buckets.

At the time of the preparation of Moore's monograph, none of the old castings for the Moore buckets could be found; but by good fortune, the pattern from which they were cast was found in the pattern storage of the Risdon Iron Works. The monograph contains front and rear views of this pattern (Fig. 5), together with a cross section made from templates fitted to it, as shown in Fig. 6. A diagram showing the method of mounting the buckets is also shown in Fig. 7.

At the Risdon Iron Works the originals of these patterns, drawings, and documents were long preserved, together with the affidavit of George Cummin, general foreman of the shop, and of John F. Skivington who made the pattern for the bucket.

In first speaking of this form of bucket, it was referred to as a joint development. It is now time to show the part taken by Prof. F. G. Hesse of the University of California in the development of these so-called Tiscornia buckets. The only



FIGS. 8 AND 9 HESSE'S SKETCHES

phrase in the Moore monograph which seems to refer to the part taken by Hesse is where he states that "after some correspondence on the subject I made . . . . ."

This may reasonably be taken to refer to correspondence with Hesse. In any event it was well known to various people in San Francisco and Berkeley, that Moore had consulted Hesse with regard to the best form of bucket and that he had, presumably, had an influential part in the determination of the form of bucket as finally adopted. The present author has discussed these points with Wm. A. Doble of San Francisco who was well acquainted with Professor Hesse and personally familiar with his work in connection with the development of this bucket form; and further, we have Hesse's own statement regarding the matter. It does not appear that Professor Hesse had ever made, on his own initiative, serious claim to the invention of the divided bucket with splitter. He was, however, drawn into the controversy by Pelton in the effort to combat Moore's claims of priority, and in a communication to Pelton under date of May 19, 1897, he states that some time between 1865 and 1868 Mr. Moore called on him (Hesse) and asked his advice as to the best water motor answering the following conditions: High head, good efficiency, and such construction as to admit of its being built of wood at the mill, except flanges, shaft, and such light castings as could be readily transported on pack animals.

Hesse's reply, given in his own words was as follows:

It is clear that, under the above conditions, only those water-motors deserve attention in which the energy of the water to be converted into work is received by the wheel in the form of kinetic energy. The tangential wheel with horizontal axis, a desirable condition, requires to be charged on its inner periphery, necessitating a large angle of entrance (the angle formed by the jet and the tangent to the wheel), causing a diminished efficiency and entailing, on account of limited space, a more costly construction. A wheel of the Jonval type with horizontal axis, the water flowing in planes parallel to the axis, seemed to answer best. It has, however, the disadvantages of being unbalanced: a serious point, considering the ever-shifting movement about the center, great number of revolutions, and large radius. Adding to this the necessity for a great number of buckets, with great length of water-way, to cause a proper discharge between the limited angles of entrance and discharge, it is clear that such a wheel would be heavy and of costly construction. I was aware of the fact that two such wheels, mounted on the same shaft, had been used heretofore to balance. (See Fig. 8.) Then it occurred to me that two such wheels might be placed together, so as to form one wheel, and one bucket out of every pair of buckets, reducing thus the entrance angle to 0, causing an increase of efficiency (Fig. 9). The jet entering in a direction tangential to the wheel is divided and discharges in two streams at the opposite sides of the wheel. Another advantage is to be found in the increased passage-way of the discharge-water, one on each side of the bucket, a fact which greatly lessens its weight and facilitates its free discharge. The best form of bucket could only be determined by actual tests and experiments, which were not made for lack of time. I furnished drawings for such a bucket to Mr. Moore, and was afterwards informed by him that castings were made

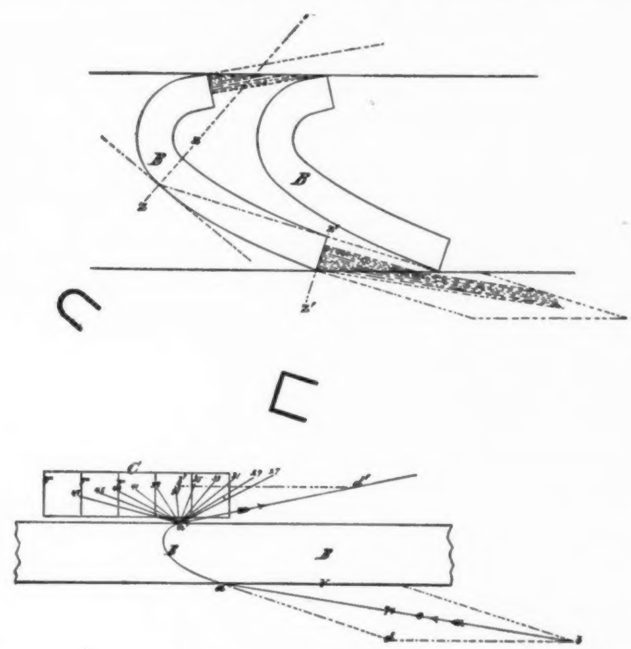


FIG. 10 PATENT DRAWING SHOWING SHAPE OF HESSE'S BUCKET

from this design, and were sent to a mine to be bolted to the rim of a wooden wheel. The result of the performance of the wheel, provided it was built, never reached me. Having never contemplated taking out a patent for what I considered so obvious an improvement, I lost sight of the matter from that time.

In the matter of dates, Professor Hesse writing in 1897, obviously depended on his memory for the date of his work for Mr. Moore, but in view of the documentary evidence at the disposal of the latter, it is evident that the correct date was 1874 rather than "between 1865 and 68."

It should also be noted that while Professor Hesse seems to have had no thought of a patent covering what to him in 1874 was "so obvious an improvement," he did, the following year take out a patent of his own under date of March 23, 1875. This patent covered a special form of bucket or water passage, together with a form of automatic governor intended to hold the speed of the wheel constant. With the latter we need not be here concerned. The former is shown in Fig. 10. The passages were curved as shown, extending through the wheel from

one side to the other, and the receiving ends were set considerably in advance of the discharging ends. The specification is accompanied further with a diagram of velocities and the principle of a reversal of the flow relative to the wheel (as nearly as practicable) and of the reduction of the final velocity relative to the earth to zero (again as nearly as practicable) are set forth clearly as well as the condition of first approach to the passage in a direction tangential to the surface, thus avoiding so-called shock. This form of bucket had no splitter. There was no attempt to divide the stream and spread it over a pair of bucket cavities. The stream was dealt with as a whole, but in a manner entirely consistent with correct hydraulic principles. It does not appear that a wheel was ever actually built, at least for commercial purposes, embodying the principles and forms covered by this patent.

It is now time to return to Pelton whom we left after he had sold out his patent of 1880 to Mr. Brayton, which served as the immediate start of the Pelton Water Wheel Co. As we have seen, the question of priority had been raised by Dodd, based on the Colman patent of 1873, by Moore based on the Tiscornia buckets of 1874, and again by Dodd based on the work of Hesse in connection with the Moore-Tiscornia buckets.

As a result of these various claims, Pelton, in May, 1897, published a pamphlet entitled "Origin of the Pelton Water Wheel," giving, as follows, his own story of his inventions.

I crossed the plains from Ohio in 1850, and engaged in mining almost continuously until 1864, when I took up mill-wrighting, in connection with mining, at Camptonville, Yuba County, and other places north of that town, in which business I was employed until 1878; and during this period I constructed a number of waterwheels, of the type commonly known as hurdy-gurdy wheels, having an efficiency of 40 per cent, and upwards, according to the style of buckets used. Here, I conceived, was a chance for improvement; and early in 1878 I procured the necessary appliances for testing the efficiency of buckets for pressure- or jet-wheels, and devoted most of the time for two years following to designing a bucket which would give a higher efficiency. I tested between thirty and forty different shapes of buckets, and finally noticed that a curved bucket having a jet-strike on the side, as in Fig. 11*b*, instead of in its center (Fig. 11*a*), gave a marked increase in the efficiency of the wheel, but caused an end-thrust against one bearing. To avoid this, I experimented with placing the buckets alternately, as in Fig. 12, when it was but a step to combining the two curved buckets and splitting the stream, as in Fig. 13. This bucket, when tested, gave such astonishing results that I immediately took steps to secure my invention.

I introduced my wheel to the public, after obtaining a patent, in October, 1880, and claim to have invented what is known as the "Pelton Water-wheel" independently, and without any knowledge whatever or aid from the efforts of others in that line.

This statement is clear, plain, and straightforward, and there appears to be no reason for any doubt as to its accuracy as a statement of fact. An interesting side light is thrown on Pelton's own statement by a conversation which he had about the time of the controversy regarding priority, with two well-known hydraulic engineers, the substance of which has come very directly and reliably to the present writer. In discussing the matter of the development of the Pelton form of bucket, he stated that, during experiments with a Knight wheel with buckets as shown in Fig. 1, the key securing the wheel to the shaft became loosened, thus allowing the wheel to become displaced along the shaft so that the jet of water now contacted the buckets at the edge instead of on the bottom of the bucket cavity. As a result of this displacement, it was observed that the stamp mill, connected to the wheel as load, immediately speeded up. This agrees with the Pelton statements relative to Figs. 11*a* and 11*b*, the first of which represents the Knight bucket under usual operating conditions and the second, as it was after displacement relative to the jet. This arrangement, however, produced an end thrust, due to lack of complete symmetry, and to obviate this the alternation of buckets shown in Fig. 12 would naturally suggest itself. And, as Pelton says in his statement, it would then be but a step to combine the right and left buckets into a single form with the two adjacent walls formed up into a single partition acting as a splitter, as in Fig. 13.

Taking into account the statements of Knight, Moore, Hesse, and Pelton, together with the general evidence regarding the existence of a prior art, it seems to be evident that in the essential elements of Pelton's bucket, and especially in regard to the splitter for dividing the jet into two equal parts, the essentially tangential approach of the jet to the bucket surfaces, and the reversal of flow within the bucket, he had been anticipated in actual point of time at least, by Colman in regard to the splitter and tangential approach and by the Moore-Hesse bucket in regard to all three points, as well as by other inventors in one or more suggestive features of form or principle of action, and still earlier in Europe, by Euler, Borda,

Fig. 11


Fig. 12

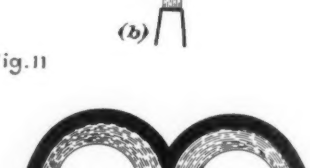


Fig. 13

FIGS. 11, 12, 13 PELTON'S SKETCHES

Navier, and others, at least so far as matters of principle were concerned.

There is, however, no probability that Pelton, in the mountains of California, was in any degree conversant with this body of prior art or prior statement of basic principles. In the conversation quoted, he recognizes the Knight bucket as the basis of the suggestion which led to his splitter and double-spoon form of bucket. The Moore-Hesse bucket, likewise, seems to have been a direct anticipation of Pelton's form in all essential features and principles of action. This form of bucket, however, was neither patented nor pushed commercially as might have been expected. Up to the time of Pelton's own patent in 1880, there does not seem to have been any commercial follow-up with wheels of the Moore-Hesse type, and it is by no means unlikely that Pelton carried on his work without reference to the features embodied in this form of bucket. The same is true with regard to the Colman patent. There was no commercial follow-up and there is no reason to suppose that Pelton knew anything of this particular form of bucket. It seems, therefore, a reasonable conclusion that Pelton, working along the line indicated in his statement, had reached the essential principles of operation and the form of bucket which he embodied in his patent of 1880. And further it is to his credit that he had faith in his invention and that he pushed the matter commercially to the point of sale, and that this patent formed the actual starting point for the long chain of later developments and improvements represented in modern forms of the Pelton wheel.

(To be concluded in the next issue)

SOME ENGINEERING ASPECTS *of* CAST IRON

By CARL H. MORKEN

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When you drive into a filling station today and order oil, you feel assured that you will get S.A.E. 20 when you order it. You have learned that, for certain conditions of weather and driving, S.A.E. 20 oil is best for your car and you insist upon using it when those conditions prevail. Even though the driver does not know or ask for oil by number, it is likely that the attendant will recommend and use the correct oil because he has a chart which was made to guide him. This is possible only because the grades of oil have been established, defined, and specified. The refiner produces these grades in conformity with such specifications; the vendors sell them and the consumers buy them accordingly.

Likewise, when S.A.E. 1020 or 3135 steel is ordered, it is with a feeling of confidence that steel will be received which conforms to certain, well-established specifications. Further than that, the engineer has become educated in the matter of selecting steel and, whether or not he knows anything of metallurgy, has learned that certain types of steel, as designated by S.A.E. specifications, perform satisfactorily under specific conditions of load. Countless other detailed specifications are available for the use of the engineer in defining and procuring a multitude of materials, but he has little help in specifying one of his commonest and most useful materials—cast iron. In fact it is probable that he is unaware of the qualities that are to be had in modern, high-grade cast iron. It also seems likely that a great many engineers do not understand what it is that characterizes different cast irons. At the risk of being too elementary for some to enjoy, the author will attempt to show some of the reactions that take place in cast iron, to illustrate why some specifications for the material are foolish, and to accentuate the necessity for creating and using workable specifications.

DEVELOPMENT OF THE STRUCTURE OF CAST IRON

Cast iron is a much more complicated material than is steel, which is well covered by specifications, now even including grain size. Aside from alloys, steel in the range ordinarily employed contains a total of some 1 to 1.5 per cent of carbon, silicon, sulphur, phosphorus, and manganese, carried in a base of 98.5 to 99 per cent iron. Of these elements, the silicon, sulphur, and phosphorus are undesirable impurities and are held at low concentrations. The manganese is comparatively inactive, unless specifically desired as an alloy. This leaves only the iron and carbon with which to conjure.

In cast iron, there is a total of about 5 to 7 per cent of the same elements, the remainder being iron. All of these elements are present in quantities which make their influence appreciable and important. The picture is further complicated by the fact that another constituent is present. In steel, all of the carbon is chemically combined; in cast iron a portion of it is combined exactly as in steel, the remainder being present as free graphite, mechanically carried in the iron. A still further complication arises from the fact that the relative amounts of combined and graphitic carbon are governed by the amount of silicon present and by the cooling rate of the casting. The sulphur, phosphorus, and manganese affect this ratio also. All of the usual alloys exert their influence, some aiding the formation of graphite and some preventing it. In addition to all of this, the physical properties of the casting are largely dependent not only upon the relative amounts of graphitic and combined carbon, but also upon the type or types of combined carbon present, and upon the size, shape, and distribution of the graphite. A very complicated picture indeed! It should be obvious, therefore, that a full knowledge of the effects of all of these reactions is essential before it is possible to specify the chemical analysis to be used in producing iron castings.

If carbon is dissolved in pure iron, the eutectic point is found at 4.3 per cent carbon. The carbon is retained as a chemical compound, iron carbide, represented by the formula Fe_3C, and is called cementite. This solution is stable and may be annealed indefinitely with no precipitation of graphite. However, the iron carbide may be changed in form, and may be present as masses of free carbide, or in layers alternated with layers of pure iron. The latter formation is known as pearlite.

When silicon is added to an iron-carbon solution, the reactions between the two elements are altered. Herein begins the divergence between steel and cast iron. As the first consideration, silicon lowers the solubility of carbon in iron approximately 0.3 per cent for each 1 per cent of silicon. Thus, at 3 per cent silicon, the carbon eutectic point is about 3.45 per cent. In addition, silicon markedly decreases the stability of iron carbide, inducing it to decompose into iron (ferrite) and graphite. With other factors remaining constant, the higher the silicon content the more rapid the decomposition. With the silicon remaining constant, the rate of decomposition increases rapidly with increasing temperature. However, at temperatures up to about 800 F the rate is so low that it can be neglected. From this temperature up, decomposition proceeds at a lively rate, the pearlite breaking down into ferrite and graphite, the process being called graphitization.

Cementite is an extremely hard constituent, above 600 Brinell or about 6.5 on Mohr's scale. It is brittle and of quite low strength. Pearlite has a hardness of approximately 225 Brinell, a tensile strength of about 120,000 lb per sq in., an elongation of about 15 per cent, and a 30 per cent reduction of area. Ferrite is very soft, on the order of 70 Brinell. It has a tensile strength of about 40,000 lb per sq in., with 50 per cent elongation, and over 80 per cent reduction of area. The properties of both pearlite and ferrite are modified somewhat by silicon dissolved in the ferrite. However, it may readily be seen that the properties of cast iron will vary tremendously as one constituent or another predominates and as divergent quantities of graphite are present to disrupt mechanically the continuity of the structure.

Since graphitization accelerates at elevated temperatures, as the iron freezes in the mold and begins to cool, the combined carbon undergoes a process of breaking down into ferrite and graphite. The heavier the casting, the slower is the cooling rate and the more complete the destruction of cementite. If high silicon is also present, the destruction is especially complete. Hence, low-silicon irons are used for heavy castings to prevent excessive graphitization, and high-silicon irons are used for light castings to prevent the retention of free iron carbide. It also follows that, to develop the ideal structure in any

Contributed by the Iron and Steel Division of The American Society of Mechanical Engineers and presented at the Semi-Annual Meeting of the Society in St. Louis, Mo., June 20–24, 1938.

casting, the composition must be carefully regulated to suit the mass and cooling rate of the given casting.

PHYSICAL PROPERTIES, COMPOSITION, AND STRUCTURE

It has been shown that pearlite has a tensile strength of about 120,000 lb per sq in., while ferrite runs only about one third

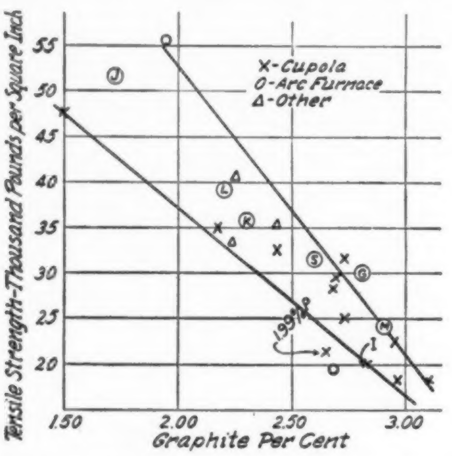

FIG. 1 EFFECT OF VARYING PERCENTAGE, SIZE, AND DISTRIBUTION OF GRAPHITE ON TENSILE STRENGTH OF CAST IRON

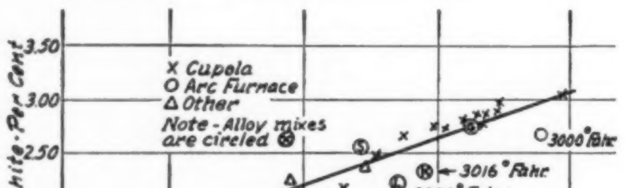

FIG. 2 RELATION OF GRAPHITE TO CARBON AND SILICON IN CAST IRON

that amount. Therefore, to develop the best strength in cast iron, a pearlitic structure is desirable. This means that the iron should show, by analysis, some 0.7 per cent combined carbon. Aside from pearlitic content, the strength of cast iron varies somewhat with the carbon content. Assuming a structure substantially pearlitic, hence with constant combined carbon, variations in total carbon content will result in nearly proportional variations in graphitic-carbon content. An increase in graphite content is accompanied by a decrease in strength, since the graphite interrupts the continuity of the structure, acts as foci of stress concentration, and facilitates intercrystalline slippage. Fig. 1[1] shows in a general manner how the strength varies with graphite content. It already has been indicated that silicon plays its part in regulating the structure of cast iron and in forming graphite. Bolton[1] has attempted to correlate carbon and silicon in his studies and bases some interesting graphs on carbon plus 0.3 times the silicon. Fig. 2 shows his representation of the manner in which the graphite content of cast iron varies with carbon and silicon. In Fig. 3, he shows how the tensile strength varies with carbon and silicon.

The general practice in making irons of higher strength is to reduce the carbon, such irons running in the range 2.75 to possibly 3.25 per cent, but with those of about 3 per cent carbon predominating. The hardness in general increases with strength, so does the toughness. Consequently, the higher-strength irons are more difficult to machine. Since cast-iron is composed of such a variety of constituents, there is not a sufficiently close relationship between hardness and strength to support a formula. The engineer should not, therefore, use hardness values to estimate the tensile strength of cast iron as he does for steel. Fig. 4 illustrates a general relationship between hardness, strength, section of casting, and structure.

The low-carbon irons freeze more rapidly than do high-carbon irons. Also, in the low-carbon irons, particularly if they have been highly superheated, the graphitization mechanism has been upset, the decomposition of cementite usually proceeding more slowly. To preserve machinability and prevent the retention of free carbides, the silicon is increased as the carbon is decreased.

Since graphitization depends, in part, upon the mass and cooling rate of the casting, it follows that a casting may exhibit different degrees of graphitization in different parts of itself. It is logical to expect the heavy sections to be softer

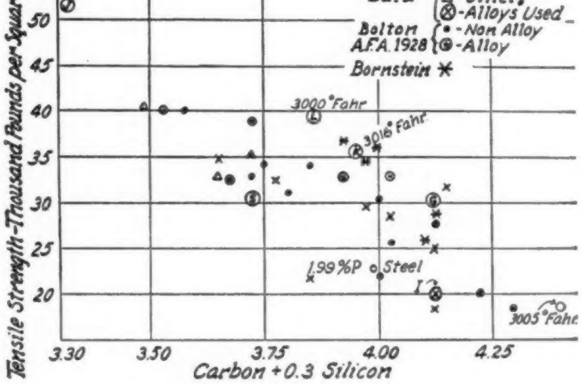

FIG. 3 EFFECT OF VARYING CARBON AND SILICON CONTENT ON TENSILE STRENGTH OF CAST IRON

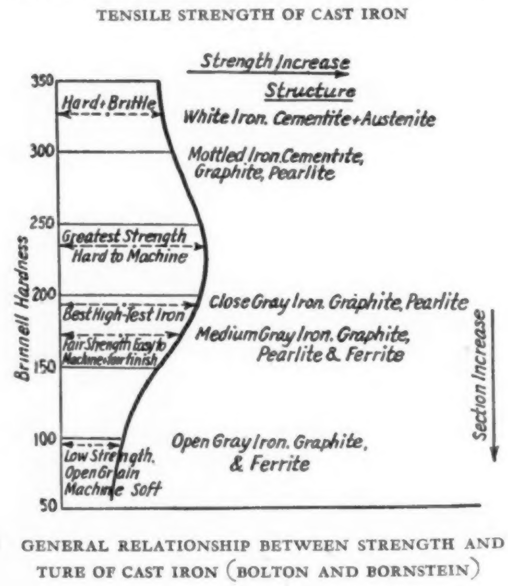

FIG. 4 GENERAL RELATIONSHIP BETWEEN STRENGTH AND STRUCTURE OF CAST IRON (BOLTON AND BORNSTEIN)

and weaker than the light parts, especially projecting light sections. The foundryman can select a composition which is a compromise between those normally required for the heavy and light sections and thus obtain average properties. How-

[1] "Gray Cast Iron," by John W. Bolton, Penton Publishing Company, Cleveland, O., 1937. The four illustrations on this page are shown by permission of Mr. Bolton and the Penton Publishing Company.

TABLE 1 STRENGTH AND HARDNESS OF CAST-IRON SECTIONS OVER A RANGE OF COMPOSITIONS

T. C. %	Si %	Bar diam, in.	Transverse properties Strength, lb	Transverse properties Deflection, in.	Tensile strength, lb per sq in.	Brinell hardness	Resilience, in-lb
		0.875	1152	0.171	24500	181	123
3.66	2.23	1.2	1860	0.273	21500	160	306
		2.0	5630	0.272	19500	165	863
3.04	2.29	0.875	1500	0.179	32000	190	158
		1.2	2132	0.282	29000	172	376
		2.0	7075	0.358	23475	155	1575
		0.875	1761	0.157	41000	236	165
3.10	1.72	1.2	3095	0.264	40000	221	487
		2.0	9682	0.323	32500	190	2010
		0.875	1665	0.142	50000	242	135
2.81	2.60	1.2	2792	0.248	50000	220	400
		2.0	11000	0.294	39000	223	1660
3.05	2.46	0.875	2730	0.231	74000	346	363
Mo	Cr						
0.63	0.49	1.2	4010	0.271	64000	345	665
Ni							
2.02		2.0	11650	0.254	52500	285	1630

ever, if high-strength iron is required and low carbon is used, it becomes increasingly difficult to preserve machinability in very light sections attached to heavy ones. Table 1 develops the differences in strength and hardness of different sections and shows that these differences persist over a range of compositions of irons.

EFFECT OF ADDING ALLOYS TO CAST IRON

When alloys are added to cast iron the effects are much the same as in steel, in addition to which is whatever influence the alloys may have upon graphitization. It is in cognizance of the latter that chemical specifications must be carefully drawn. Because their application requires little or no investment, alloys are playing a rapidly increasing part in the production of cast iron. By the same token, however, too frequently attempts are made to work with alloys at foundries where neither adequate knowledge nor control facilities exist for their intelligent application. No alloy is a panacea for castings troubles, nor can any produce the desired results unless properly applied. Indiscriminately used, alloys can and do lead to much trouble.

Nickel is perhaps the most commonly used and specified alloy, yet it seems that many do not realize what it does to cast iron. Unquestionably its advantages and uses have been exaggerated and have confused many engineers not versed in metallurgy. Nickel is a graphitizer in somewhat the same manner as silicon. In graphitizing power, it is about one fourth as effective as silicon, but differs from it in one important respect. Nickel facilitates the decomposition of free carbides, breaking them down to the softer pearlite and graphite. It, however, has little or no influence over the combined carbon of the pearlite. It is useful, therefore, in reducing chilled edges and for reducing the hardness of light projections of heavy castings. Since the hardness of a pure metal is usually increased when another metal is dissolved in it, nickel increases the hardness of iron. Small amounts, however, have little or no effect upon the strength of iron, and frequently are found to reduce it. Since nickel is a graphitizer, it follows that, if it be added to iron which contains as much silicon as should be used for a given casting, the added graphitizing power is likely to cause internal shrinkage due to excessive graphitization. Reduced strength, hardness, and density follow automatically. Nickel does promote uniformity of structure and serves somewhat to break up the graphite into finer particles. When it is to be used, the composition of the base iron should be revised and the silicon decreased in compensation.

The effect of chromium is opposite to that of nickel. It is an inhibitor or retarder of graphitization and serves to promote stability of iron carbide. Chromium forms its own carbides which are harder than iron carbide. Its use alone is limited largely to castings not requiring free machinability since small quantities form sufficient carbides quickly to ruin even the best of tools. Chromium is a real strengthener and toughener and is useful in castings to be heat-treated, since it prevents excessive graphitization while treating to improve the structure of the matrix.

Because of their opposing tendencies, it is only natural that nickel and chromium should be used together. The chromium offsets the softening effect of the nickel, while the nickel tempers the hardening effect of the chromium. The combination, used in the proper base iron, increases strength and hardness and improves the uniformity of structure.

It is a common belief that this alloy combination produces heat resistance in cast iron, but the data show that the small quantities ordinarily used are of doubtful economy since the proportionate increase in life is low. High-alloy contents are required to produce substantial increases in the life of parts subjected to a service which causes growth or scaling.

Molybdenum is another carbide-forming element, but to a lesser degree than chromium. "Moly" goes into solution in the ferrite, strengthening and hardening it. The author has found that as small an amount as 0.2 per cent increased the hardness of a ferritic iron as much as 30 Brinell numbers, and yet there was no combined carbon to be found. Molybdenum also exerts a profound effect upon the graphite of cast iron, causing it to precipitate out in small, less-jagged particles. This automatically increases the strength. Molybdenum also promotes uniformity of structure, tending to produce the same hardness across heavy masses of casting. Since it is a toughener, it is good practice to use somewhat higher silicon with molybdenum. An alloy combination that has much merit for the production of strong, tough, dense castings is nickel-chromium-molybdenum. Used in a properly balanced base iron, very high strengths are obtainable with this combination, over 60,000 lb per sq in. tensile strength being daily routine in the foundry with which the author is connected.

Copper, as an alloying element, is being more widely used in cast iron. It reacts in much the same manner as nickel, is a mild graphitizer, and has little effect upon strength. Because of its lower cost, copper is finding favor as a substitute for nickel in the lower concentration ranges. The author has examined iron of excellent quality made with copper-molybdenum combinations.

No discussion of alloys in cast iron would be complete without at least mentioning "Ni Resist" and "Ni Hard," two intensely important members of the family. These names are copyrighted by the International Nickel Company and the alloys are produced under license agreement with that company. Substitutes for either frequently lead to trouble.

Ni Resist is an austenitic alloy of cast iron of the following nominal composition:

	Per cent		Per cent
Total carbon....	2.75–3.00	Nickel..........	14.00–16.00
Silicon..........	2.00–2.50	Chromium......	2.00– 3.00
Manganese......	0.75–2.00	Copper.........	5.00– 7.00

The alloy is quite soft, usually running in the range of 150 to 200 Brinell. Its tensile strength seldom exceeds 40,000 lb per sq in. and usually runs from 20,000 to 30,000. Ni Resist is less brittle than plain cast iron, actually taking a permanent bend before breaking. It is nonmagnetic, oxidation-resistant, and shows excellent resistance to many types of chemical corrosion, including autoelectrolysis. Its uses include innumerable parts for handling aerated water, brines, acids and alkalies, where the use of expensive stainless steels is not justified and where the

life of plain cast iron is low. In high-temperature applications, where sulphur gases are not encountered in large quantity, it gives good service and is practically immune to growth. Another interesting feature of Ni Resist is its wearing quality. Soft as it is, this alloy often outwears to a considerable extent some of the very hard metals in handling mildly abrasive materials, such as slaked lime and similar suspensions of solids in more or less corrosive media.

Ni Hard is a martensitic alloy of cast iron, of the following nominal composition:

	Per cent		Per cent
Total carbon........	3.0–3.5	Nickel............	4.0–5.0
Silicon.............	0.5–1.0	Chromium.........	1.5–2.0

Such iron is, of course, white as cast, and usually ranges from 550 to 700 Brinell, depending upon the method of casting. Plain sand castings usually run from 550 to 600 Brinell, while those cast on chills reach and sometimes exceed the higher limit. The tensile strength usually approximates 60,000 lb per sq in., and by heat-treatment can be brought up to about 80,000. Since this type of alloy is hard as cast, it requires no cold working to develop maximum hardness and resistance to abrasion. It is extensively used for extrusion dies, ceramic molds, muller tires, mixers, grinders, etc., and in pumps for handling abrasive mixtures. In such applications, Ni Hard frequently outlasts manganese steel four or five times.

HEAT-TREATMENT OF CAST IRON

Any cast iron can be heat-treated. The metal, since it has the fundamental structure of steel, responds to heat-treatments in exactly the same manner as steel. Furthermore, it can be annealed, stress relieved, hardened by quenching, and tempered by drawing. In designing any heat-treatment, however, the fundamentals of structure formation earlier treated must be remembered. Subjection of cast iron to temperatures above 800 F accelerates graphitization with consequent weakening; likewise, subjection to temperatures above 1450 F induces solution of the carbon. In the latter case, since the carbon content is relatively high, in quenching there is likely to be retention of large masses of carbide.

In general, heat-treatment is of little avail for improving poor, open-grained cast iron with large graphite flakes. It is effective for improving still further the structure of fine-grained iron of small graphite flakes. The use of alloys usually stimulates the response to quench-draw treatments, but some of them, as pointed out, effectively defeat annealing treatments.

Two different types of heat-treatment of cast iron frequently lead to confusion. Annealing is truly a softening treatment. It involves heating the castings to a point well above 1450 F, holding until the carbides are broken down, and then cooling slowly in the furnace. Even when disposing of objectionable carbides in this manner, attention is again called to the graphitization that inevitably accompanies it. Stress-relief treatment consists in heating the castings to a temperature well below 1425 F (usually from 900 to 1100 F), soaking 1 to 3 hr per in. of section, and cooling very slowly—the more slowly the better. This treatment serves to dissipate any internal stresses that may have been locked up in the casting during freezing and cooling in the foundry. It softens the iron only a very little, because of some graphitization of the pearlite, but this softening can be minimized by the use of alloys.

Normalizing is a term applying to steel technique and consists of heating above the critical range and quenching in air. It may be followed by stress-relief treatment. Thus defined, it is seen that "normalizing" is not synonymous with "stress-relief" treatment and has no application to usual cast-iron practice. It is obvious that an anneal and stress-relief treatment can be accomplished simultaneously. This double effect merely involves very slow cooling down to about 400 to 500 F, after the annealing soak has been accomplished.

SEMISTEEL A MISNOMER

Many engineers still are misled by the term "semisteel." Frequently specifications are issued which call for 15 per cent steel, 25 per cent steel, or some other steel percentage, the engineer confidently believing he has solved his casting problems with a superior article. "Semisteel" is a term which has no meaning, is impossible to define, and gives the engineer no assurance whatever that he will obtain any of the properties desired.

The addition of steel to the cupola charge was an early attempt to produce stronger iron by reducing the carbon content. In those days, the foundrymen thought they had achieved a material half way between cast iron and steel in its properties. The fallacy of this idea is recognized today and it is realized that the material still is just plain cast iron.

When iron is melted in the cupola it is in constant contact with incandescent coke. As the drops melt, they trickle down through the coke and collect at the bottom of the cupola, still in contact with white-hot coke. The amount of carbon which the iron will absorb from this coke is dependent upon such factors as the composition of the iron, composition and structure of the coke, amount of air blast used, speed of melting, and length of time in the cupola well before tapping. With nicely regulated and controlled melting practice and with proper attention being paid to these items, low-carbon iron can be made by using steel in the charge, but the structure developed in the casting will still be dependent upon the use of a properly balanced analysis for that casting. Many foundries are making an excellent grade of high-carbon soft iron from cupola charges high in steel. The author has visited two foundries which are using 100 per cent steel charges to make very soft iron for small castings, requiring high-speed machinability.

In the electric melting furnace it is different. Here there is no carbonaceous fuel to carburize the metal. If 100 per cent steel be charged into it, steel comes out. If the charge be 50 per cent steel and 50 per cent pig iron, the product will have a carbon content approximately half that of the pig iron. Thus, steel reduces the carbon content of the electric-furnace charge by simple dilution. The melter can combine his materials in such a way as to produce any desired carbon content between that of low-carbon steel and pig iron. Furthermore, in the electric furnace, carbon can be oxidized out of the metal in controlled amounts by manipulation. It can also be added to the metal under control by the addition of flake graphite, coke, or any other similar material of known carbon content.

SPECIFICATIONS FOR CAST IRON

In collaboration, the American Foundrymen's Association and the American Society for Testing Materials have worked on the intricate problem of devising specifications for cast iron. This work, together with the individual efforts of other societies, has brought forth some specifications for cast iron, but they are not widely used. From the viewpoint of foundrymen who produce "engineered castings," the existing specifications fall short of providing the engineer with a means of prescribing his material. Perhaps he is not asking enough of the foundry; if so, it is because he does not realize what is available for his use.

Even today, the principal items in a cast-iron specification are likely to be: ". . . . the castings shall be sound in every respect, conform accurately to pattern, and be of suitable, smooth surface finish." Frequently the specifications will include that the castings be made of "semisteel," even stipulating the amount of steel, or they will require them to be made of some sort of "—ite," which is little better, because it sig-

nifies little beyond particularizing the foundry which makes it. One large concern, well equipped with designing engineers, recently released specifications for a fairly large lot of castings, the sole requirement being, ". . . the castings to be made of 1.5 per cent nickel cast iron." The castings covered ranged in size from 2 or 3 lb to 1200 lb. The engineer who wrote that specification wanted better metal than "run-of-mine" cast iron, but did not realize that his specification assured him of nothing in the way of properties. It could be met perfectly by any foundry which would add the required amount of nickel to the stream as the iron ran from the cupola spout. The specification could also be met by any foundry which chose to pour all of the castings from a single heat of metal. As has been shown earlier, this would result in highly inferior castings somewhere along the line, either at the light or heavy end of the scale. Furthermore, if nickel be added to a high-carbon, high-silicon iron it would add to the dissatisfaction of the user.

The U. S. Navy has an iron specification to cover certain pump parts. Among other things it calls for the following properties: carbon, 3.0–3.1 per cent, silicon, 2.2–2.3 per cent, alloys and other elements specified, transverse strength, 3500 lb (1.2-in. bar), deflection, 0.25 in. (18 in. on centers), tensile strength, 55,000 lb per sq in., minimum.

This same specification accompanies every order, irrespective of the size, mass, or design of the castings. As frequently happens, it is too hard or too soft for the castings ordered. In such instances, it all but requires an act of Congress to apply a temporary specification.

The A.S.T.M. specifications now cover cast iron in a general way and in a manner more to avoid undesirable characteristics than to define desirable ones. These specifications cover soil pipe, culvert pipe, automotive castings, valves, flanges, and pipe fittings. These have been augmented by A48-36, which is intended to cover gray-iron castings not otherwise specified. This specification classifies cast iron into seven groups, whose class numbers, 20, 25, 30, 35, 40, 50, and 60, designate corresponding minimum tensile strengths in thousands of pounds per square inch.

Transverse tests are optional. Three test-bar sizes are provided, the idea being to select the one which most accurately simulates the section to be cast. While specifications, based upon these bars individually, are far more accurate than would be the case with only one bar for all purposes, it remains true that no test bar can with certainty reproduce the properties developed in a gray-iron casting. This is because of the differences in properties caused by differences in mass-cooling rate with its attendant effect upon graphitization. The test bar, then, is merely a yardstick with which to judge the general quality of the metal. This is brought out in Table 2, in which are tabulated six irons of A.S.T.M. Specification A48-36. As measured by the 1.2-in. bar, these irons are all class No. 35, with the exception of the sixth, which is class No. 40. While the tensile strength remains relatively constant, other properties vary widely. This is especially notable in the transverse strength of the 1.2-in. bar, which varies 32.2 per cent from low to high; and in the resilience figures, which vary from 75 to 155 per cent, low to high.

To the uninitiated, the resilience figure is new and is rapidly becoming popular. It is determined from the stress-strain diagram of a bar under transverse loading. The resilience is an expression, in inch-pounds, of the area under the curve bounded by the zero point, the ordinate of the breaking point, and the base line. It seems to be an excellent measure of toughness.

TABLE 2 STRENGTH AND HARDNESS OF A.S.T.M. SPECIFICATION A48-36 CAST IRONS

No.	T.C. %	Si %	Bar diam, in.	Transverse—properties— Strength, lb	Deflection, in.	Tensile strength, lb per sq in.	Brinell hardness	Resilience, in-lb
			0.875	1589	0.196	40000	203	215
1	3.34	1.47	1.2	2680	0.320	37000	198	588
			2.0	7938	0.326	32250	182	1718
			0.875	1761	0.157	41000	236	165
2	3.10	1.72	1.2	3095	0.264	40000	221	487
			2.0	9682	0.323	32500	190	2010
			0.875	1615	0.156	41500	207	147
3	2.98	2.00	1.2	2372	0.244	37000	192	359
			2.0	8212	0.320	31000	181	1705
			0.875	1560	0.165	41000	221	163
4	3.21	1.82	1.2	2720	0.325	35500	218	594
			2.0	8190	0.339	30000	194	1910
			0.875	1540	0.143	40000	208	123
5	2.75	1.93	1.2	2420	0.225	39000	212	314
			2.0	8970	0.304	31500	194	1600
			0.875	1820	0.182	45500	228	211
6	2.93	1.75	1.2	3140	0.371	41500	217	800
			2.0	10116	0.414	36500	200	2870

The tabulation shows a wide variation in chemical analysis between irons of about the same tensile strength. A hidden fact is that all of these irons are not suitable for pouring the same castings. None is correct for light castings, Nos. 1 and 3 being the softest and suitable for medium-light work. Nos. 2, 4, and 6 are of a type for somewhat heavier work and lead to hard edges on light castings. No. 5 is a tricky iron, likely to lead to internal shrinkage, where the section of the casting is not uniform; and, with all these properties, there is not even a hidden hint of machinability, wearing qualities, ability to withstand heat shock, or many other qualities of interest to the engineer.

So much more can be done! Today, in many of the better foundries, cast irons are being produced, having qualities to meet one or a combination of requirements of the engineer. The following constitute but a few of the applications for which highly improved irons are available:

1 Mechanical strength. Tensile strengths up to at least 80,000 lb per sq in., without heat-treatment.

2 Strength combined with toughness, as expressed by the "resilience" figure or impact tests.

3 Of composition rendering the castings especially suitable for heat-treatment.

4 Controlled hardness.

5 Of definitely superior qualities for resisting each of many types of wear.

6 Improved corrosion resistance for a wide variety of reagents and conditions.

7 Heat resistance and ability to withstand even severe oxidizing conditions.

8 Iron that does not distort after machining, but which will retain accurately machined dimensions indefinitely.

9 Nonmagnetic cast iron.

10 Iron of high expansion characteristics.

11 Iron of very low expansion characteristics.

12 Iron which is stable at extremely low temperatures.

Since there is no reference book in which are listed the specifications for procuring these irons, it remains for the engineer, with the cooperation of his foundrymen, to find, by the cut-and-try method, what is best for his needs. The production of cast iron is not precise enough for "cook-book" methods, even though much of the mystery has been removed. However, after a suitable type of iron has been found for the job, a specification for it can be written in such a way as to give reasonable assurance of day-to-day reproduction. Most good foundries welcome such specifications.

ORGANIZATION PROBLEMS *of* BRANCH MANAGEMENT

By PAUL L. DAVIES

FOOD MACHINERY CORPORATION, SAN JOSE, CALIF.

THIS article discusses the fundamental principles which must be given consideration in operating various branches of a corporation in order to obtain the best results from each individual branch. Therefore, it will cover, first, the procedure to be followed if we were starting a branch plant in some new location and the factors that would warrant consideration, and, second, the problems that would be presented for solution after the branch had been established and operated for a period of time. For discussion purposes, it will be assumed that this branch plant incorporates the maximum of problems involved, namely, the complete supervision of the functions of selling, manufacturing, engineering, and credits.

For every function added, the problems of supervision are multiplied but inasmuch as the various divisions of our company operate on this basis, I feel that I am in a position to discuss this complete type of organization. Those of you who are interested in plants involving only one or two of these functions should consider only those in which your interest lies.

PERSONNEL

After deciding on the location of the branch plant, the first problem is to choose from our present organization the proper personnel for directing the activities of the newly formed branch. What qualifications do we feel are essential for the man we are to pick as manager?

First, the manager should be, if possible, an individual who has been trained in our home-office organization and, by experience, should have acquired a working knowledge of the policies of the company. An acquaintance with the executives at the home office is most valuable, as it is much easier to take up subjects by correspondence if you are familiar with the type of individual you are dealing with. If instead of starting a new branch, we should acquire a plant by purchase and expect to operate it as a division of the company, it would be equally valuable to bring to the home office the man selected to manage the new division and have him spend a period of time getting acquainted with the executives and learning the operating policies of the company.

Second, the manager should have had some executive experience. It is not necessary that he should have had previous experience as a manager but he should have had sufficient responsibility to have proved that he is able to handle men and is able to assume executive responsibility. When he assumes his duties as manager of the branch, he will be dependent to a large extent on his own resourcefulness. In some cases, we have made the mistake of sending out a man who had a fine personality but had not proved his ability to take responsibility. So, when he actually came "under fire," he quickly proved that he did not have the ability to handle the work.

Third, the manager should be an individual who has further possibilities of advancement. We endeavor to operate our divisions so that they are training schools for future executives. We are opposed to having branches as dead-end positions for executives and, consequently, some of our branch managers in the more important divisions have positions equal in responsibility to executives at our home office.

The same fundamentals in a lesser degree apply to the key men chosen for the operating positions in the new branch. The assistant manager should be a man who is capable, with training, of taking over the manager's position. We endeavor as far as possible in all of our divisions to have an understudy for every important position. The sales manager, the division engineer, the production superintendent, and the credit and office manager, should all be men who can handle not only the routine of their immediate duties but who will be of assistance to each other in a counsel group and have possibilities of advancement.

The board of directors of our company designates an executive committee of five members to determine the operating policies of our corporation, the committee being composed of the president, the executive vice-president, the vice-president in charge of production, the vice-president in charge of sales, and the vice-president in charge of engineering.

In our branches a similar executive committee meets and determines the operating policies of the branch. The primary responsibility is, of course, with the manager but we find that an executive committee of this type meeting in the branch is not only an excellent training school for the individuals who counsel together, but also leads to the exercise of very sound judgment in deciding matters of policy and increases the interest of all of the key men in the branch organization. Minutes of the meetings of the branch executive committee are kept and forwarded to the home office for the permanent files.

FURNISHING CAPITAL REQUIREMENTS

Now that our personnel has been selected, the next step is to decide on the capital requirements of the branch. Of course, a budget as to the amount to be spent for physical facilities will be prepared by the executives at the home office. But what of the future? Should we endeavor to control all the expenditures of the branch from the home office or should we furnish the funds and put a brake on the use of these? I believe the latter is the proper course to follow. It helps develop management judgment, analysis, and a sense of responsibility. We charge our branches interest on the funds they use at the average rate the corporation pays for its funds, plus a loading for home-office overhead charges. This becomes a fixed charge that the branch has to earn before it shows a profit. The charge is based on the amount of capital used in the branch which, of course, includes the total receivables, inventory, investment in fixed assets, and other charges, less any liabilities that may be outstanding.

We have found that this method of controlling the amount of funds used by each branch is very effective and provides experience for the manager and the executive group of the branch. Every transaction is analyzed in the light of the amount of money that can be earned by the transaction and the charge for capital which must be taken into account. In the early days of each manager's experience, no doubt, mistakes will be made, but

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in the long run, the manager will see for the most part "eye to eye" with the home-office executives in reaching decisions which involve problems dealing with the utilization of corporate funds.

METHOD OF COMPENSATION

Probably the system of making a fixed charge for the capital used in the business would not be nearly as effective if we did not tie in with this a method of compensation by which our managers and key men in the branches receive not only salaries but also a bonus based on the profits of the branch. We feel that this accomplishes a dual purpose. First, we are able to keep the salaries of our executive group on a more even keel and, in good times, the increase in compensation is automatically taken care of by the increase in earnings of the branch. In the second place, we have found that over a period of time, our managers and key group, whether at the home office or in the branches, are able to save money if they receive their bonus in a lump amount at the end of each fiscal year, rather than having it anticipated and paid to them monthly.

CENTRALIZATION OR DIVERSIFICATION OF DEVELOPMENT

In deciding on the scope of operations of the branch to be established, one of the first subjects on which decision must be reached is whether development work is to be carried on by the home office or the branch. The answer to this question, of course, involves a number of decisions which have to be made, such as the type of development work to be done, the type of engineer to be in charge of the branch operations, and the field in which the branch is to operate.

In our company we have found that it is essential that each branch carry on its development work under the general guidance of the chief engineer. I am sure you can easily understand the reason for such a decision, for the problems of the vegetable canner in Indiana differ substantially from those of the fruit canner in California; processing of apples in Washington is entirely different from the problems of handling citrus fruits in Florida; and the manufacture of turbine pumps and development work necessary for high efficiencies and low cost present an entirely different group of problems from the manufacture of agricultural implements and sprayers at our plant in Lansing, Michigan.

If our company were manufacturing only one line of equipment, such as electric motors, or household appliances such as washing machines, electric-refrigeration units, or other similar types of equipment, then it would be perfectly logical to control the development work at one point and have the branch operate as an assembly plant or manufacturing plant without the responsibility for development work.

However, even though our development work is centralized in the branch, it is necessary to maintain control not only of the amount of development expenditures but also of the type of development. Our chief engineer accepts the responsibility of approving the mechanical design of the equipment developed by the branches and our executive committee has the responsibility for passing on the amount to be spent on individual developments and the scope of the developments. Before any project is approved, forms must be submitted by the management of the branch setting forth the estimated market for the equipment to be developed, the estimated cost and selling price, and the engineering and preliminary development expense anticipated.

In our business, development of new equipment is really the life of the business and, therefore, it is essential that we have men of outstanding ability in charge of the engineering work in each of our branches. It is, of course, also important for our chief engineer to visit the branches periodically and check over their development work, as well as make suggestions about additional work to be undertaken.

ACCOUNTING AND RECORD KEEPING

Having decided on our capital investment, the method of allocating funds, and our engineering and development policy, our next step is to provide a system of cost and general accounting that will give the branch management and the home office a complete and accurate picture of the branch business at regular specified periods. In this connection it is necessary to have a uniform chart of accounts so that the various operations and expenses will be classified under the same headings and that it may be possible to prepare a consolidated statement of corporation operations that can be presented without a mass of changes and adjustments. Each branch is also required to submit periodic reports covering orders taken and billings to customers, as well as a daily report of cash deposits and withdrawals.

EMPLOYEE RELATIONSHIPS

The decision as to whether employee relationships are to be handled from the home office or by the branch management is a most important one. It involves the question of whether the employees are to consider their loyalty to the branch, or to the main office, or to both. I believe a combination of the two policies is most desirable. The employees must feel a real sense of responsibility and loyalty toward the local management but at the same time, a general policy on handling employee relationships must emanate from the board of directors.

For example, our corporation has a profit-sharing plan which has been in operation only a short time. The basis of the plan is that earnings over and above a reasonable return to stockholders are divided on the basis of 80 per cent to the stockholders and 20 per cent to the employees. This policy, adopted by the board of directors, obviously affects the welfare of all employees and is therefore a corporation policy. On the other hand, the management of the branch has the responsibility of explaining the operation of this plan to the employee and of selling the employees on the soundness of the plan. We feel it is always advisable to clear through the branch management all personnel policies and to have the employees of the individual branch look to the manager of that branch and not to the home office for the solution of their problems.

While the executives of the home office are constantly discussing with the branch management group questions of personnel policy, nevertheless, the primary responsibility for happy employee relationships is with the branch management.

LINE OF AUTHORITY FROM HOME OFFICE TO BRANCH

One of the most important questions to solve in the management of branches is how to keep in close touch with the operations of the branch and, at the same time, allow the branch to function as an independent unit. There are, of course, certain crossing of functions that tie in naturally. The engineer in charge of the branch engineering will look to the chief engineer for advice and counsel but, in order to maintain the proper management relationship, the line of authority must come direct from the manager to the division engineer. For assistance on credit problems, the credit manager of the branch may consult the treasurer of the company, but for the determination of credit policy as it affects the operations of that branch, instructions must come from the manager. The same is true of each department head and the manager is the final authority for clearing all matters with the executives at the home office.

The next question is how much leeway should be allowed the branch manager. Where does his authority begin and where does it end? Our answer to this is that it is impossible

to lay down hard and fast rules because different managers deserve varying ratios of authority in accordance with their ability. In an endeavor to keep control of branch management policies, it is of paramount importance that we do not lessen the responsibility of the manager and his group. In other words, the general operating policies of the corporation should be well understood by the management and whenever in doubt as to procedure to follow, the branch manager should counsel with the executive committee or with the executive officers of the company.

However, in our type of business, we depend primarily on our management group in the branch to operate the plant successfully. It is true that the home office controls capital expenditures in excess of a minimum amount, as well as development expenditures and other items that affect the welfare of the corporation as a whole but, by training managers in the policies of the company over a period of time, the managers and the company's executive officers have little cause for difference of opinion.

It is, of course, essential that the home-office executives make frequent trips to the various plants, for it is impossible by correspondence really to keep their fingers on the pulse of the business at any given branch. Nevertheless, our tendency is more and more to place increased responsibility on the branch management after we get the right men in charge and know that they understand the general policy the home office wishes them to follow.

CONTROL OF OPERATIONS BY BUDGETS

At the beginning of every fiscal year, we require the management group at each branch to prepare a budget; and a consolidated budget of the divisions plus the home-office budget makes up the operating budget for the corporation for the ensuing fiscal year. This budget includes estimated sales, inventories, expenses, receivables, and profit-and-loss statement for the coming year by quarters. In addition, it reflects the amount budgeted for development and capital investment, as well as a breakdown by accounts for factory expense, sales, advertising, and administrative expense.

The purpose of making the budget up by quarters is so that it can be compared at the end of each quarter with the actual operating results attained. If the guesses made on sales, or expense items, or balance-sheet items, appear to be materially out of line, then drastic changes in operating policies can be adopted.

PATENT, TAX, AND LEGAL DEPARTMENTS

Omitting the general executive functions which obviously must be carried out at the home office, there are certain other departments, such as patent, tax, and legal departments, which, because of their specialized nature, cannot be broken down into branch-plant activities but which do have a very material bearing on the problems of branch-plant management.

In our company, we employ four patent attorneys who are constantly kept busy with applications for patents, infringement by others of our patents, alleged infringement of patents of others by our company, and investigations regarding new developments which we anticipate undertaking.

Consequently, the patent department is one of the most important divisions of our business. If it were not for the protection we are able to obtain for our developments, we would be unable to continue in business. We spend and budget a percentage of our cost of sales for new development work. If competitors could copy equipment which we develop without having the cost of such development to absorb, then we would soon go out of business. It is, therefore, essential that we not only spend the money for development but after we spend this money, that we be able to protect the developments which we have made. The patent department has to be in constant touch with the branches and it is necessary that someone in each branch be designated to follow patent matters, as this is a technical subject that requires real study and planning, as well as experience.

It is obviously impossible to have a tax expert at each branch but many transactions handled, both at the branches and at the home office, have to be viewed in the light of the tax policy of the corporation. Therefore, we have an officer of our company whose primary duty is to follow tax matters. Whenever a piece of equipment is purchased, a machine leased, or a building built, depreciation policies must be evolved. Whenever a contract is entered into covering the purchase of a business or the purchase of an invention, this contract has to be reviewed in the light of the possible effect on our taxes. Therefore, the management of the branch has to be tax conscious, and work closely with those in charge of our tax department.

Wherever we have a branch, we have a local counsel. We find that this is essential, for in the operation of each branch there are times when the management wishes to discuss particular situations with a local attorney. However, we also have our general counsel who handles all company litigation.

In addition, we have our own attorney who passes on forms of sales contracts, follows the changes in the laws of various states that affect the operations of our company, and, in general, handles the detailed legal problems of the corporation. All contracts and litigation affecting the company clear through the central source of our legal department.

CONTACT BETWEEN BRANCH AND COMPANY EXECUTIVES

In addition to frequent visits of home-office executives to the various branches, we find it is also advisable to have the branch managers and others in the management group of the plant visit the home office once a year if possible. We also find a meeting of managers is most helpful for a discussion of mutual problems and for the formulation of policies and standards of operation of the various branches. Often the methods that one branch manager has used in solving the particular problems in the operation of his branch are most helpful to other branch managers.

TRAINING OF OPERATING PERSONNEL

Because of the varied nature of the various branch operations and the geographic location of the branches, it is difficult to adopt a uniform personnel policy for training junior executives. However, we do recognize the responsibility for such a program in a well-managed concern today and endeavor each year to employ a quota of business-school and graduate engineering students in order to train each individual for a future position of responsibility in the affairs of the corporation.

SUMMARY

While we have covered a great deal of territory in our discussion of the problems of branch management and have probably referred to an excessive extent to problems of the company I happen to be interested in, nevertheless, I feel we have explored the subject far enough to come to certain conclusions about fundamentals essential for proper branch management. To clarify our discussion I am going to enumerate once more these essentials as follows:

1 Branch management personnel must be competent, trained in corporation policy, have executive ability, and possess the capabilities of future advancement with the corporation.

2 The executive committee or executive officers of the

(*Continued on page 464*)

THE PRICE OF SECURITY

By DWIGHT L. PALMER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BY THEIR many overt expressions of opinion as well as by their recent individual and collective action, the American people have declared themselves in no uncertain terms to be desirous of an enlarged measure of economic security. This undoubtedly does not mean that they have willfully elected to forego the benefits of further increases in physical production or of a rising standard of living. Rather it may be interpreted as a preference for less uncertain although slower economic development in place of playing for higher economic stakes at higher odds. If this choice were actually as straightforward as it appears, it would be difficult indeed to criticize a decision so demonstrably appealing to so wide a segment of the public.

It is possible, however, that in our society no such apparently simple choice may be made between economic change and economic security, but that instead both are gained or lost together. In the elaboration of this far from generally accepted view Prof. Allan Fisher has presented a most able and timely analysis of a major American phenomenon.[1]

In presenting his views, Professor Fisher writes for the economist and the general reader alike, but his emphasis is primarily on the economic aspects of his subject. For example, it is not to the engineer's function in facilitating material progress that attention is directed, but to that of the economist. The problem stressed is not that of producing all the bridges *or* all the houses we could use but rather that of producing all the bridges *and* all the houses we actually want in light of our limited supplies of resources available for production in these and other lines.

In this connection, it is perhaps the outstanding theoretical appeal of individualist economics that full adoption of its methods would so order a progressive society's increasing technical resources that an enhanced standard of living would automatically result. It is self-evident that this rising income level necessitates changes within the industrial structure. Accordingly, the first premise in the present analysis is that, in a progressive society, change is implicit.

To clarify this, it is possible to divide the economic sphere into three productive areas. There are the primary industries concerned with the production of foodstuffs and raw materials. There are the secondary industries whose function it is to modify the form and thus enhance the usefulness of these simpler physical products. Thirdly, there are the "tertiary" industries whose chief characteristic is that they cater to the whims and "luxury" desires of man and whose output consists largely of personal services rather than of tangible, physical product.

Slowly, but cumulatively as the inventive genius of a people gives it increased control over its resources, the center of balance of production advances through these three fields. In the nineteenth century, western Europe and America shifted to the second area and a diminished reliance on primary production was foreshadowed, the repercussions of which have not yet worked themselves out in a world of accumulating agricultural surpluses. It is Professor Fisher's contention that we are now faced with the need for a parallel shift of our center of balance into the "tertiary" industries in order to achieve further enlargement of real income. He argues that without this shift the possibilities of our technological advancement cannot be translated into industrial achievement, and further material progress will be rendered impossible.

Once a society has progressed as far as ours, its further material advance is attainable only through such a redistribution of its productive resources (natural and human) as will decrease that proportion of its efforts going into primary and secondary production and increase the utilization of its productive assets in developing the "tertiary" industries. Such are the changes required of a people committed to an increasing standard of living and no sentimentalized appeal to an historically interesting but currently inappropriate list of "basic" industries will avail. To a progressive society change means that some industries must expand while others shrink and decay. This is its sole means to a rising standard of real income. As Professor Fisher has worded it: "Rising income-levels will always mean, are in fact the same thing as, changes in the relative importance of different kinds of production." Thus we are led to a second conclusion: "In a progressive economy, increases of production must always be asymmetrical."

Far from welcoming the potential increase in luxury and service trades as less and less productive effort is necessary to meet the needs of the primary and secondary areas, it is as if our society were purposely intent on preventing the advent of this presumably welcome change. The reason for this apparent inconsistency is not hard to find. "Material progress means change, and change frequently inflicts much inconvenience and suffering upon individuals directly affected . . ." "Everybody wants to be more prosperous, but nobody wants to leave the occupation in which fortune, good or bad, has placed him."

Nor is this resistance confined to any one group. Those romantically intrigued by agriculture preach a specious sermon based on the text "back to the land." The laborers strive to protect their skills by local and national craft monopolies. The manufacturers seek by all the means at their disposal to hold their accustomed markets and seemingly refuse to enter the needed luxury and novelty industries where production is difficult and risk is great. The wealthy, enjoying their privileged position, put increased store by security and make every effort to prevent change which might deprive them of their differential advantage. The professional workers whose ranks must be augmented if society is to enjoy the increased income now possible to it from the "tertiary" industries, raise technical hurdles and resist with demonstrable effect the diversion of workers from other industries into these in which expansion is presumably most urgent.

Perhaps the clearest example of this basic resistance to change is that of the investor. As Professor Fisher has phrased it, "there is a fundamental conflict between the demands of material progress and the individual capitalist's desire for personal security." As the new and needed "tertiary" industries are as yet unpioneered, investment in them is risky and uncertain. Each investor then in refusing to help in the financing of new industries follows sound individual theory. But the attendant difficulty is that, with most investors doing this, the very industries that must expand if society is materially to

[1] "The Clash of Progress and Security," by Allan G. B. Fisher, Macmillan and Co., London, 1935, 234 pages.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

progress are prevented from finding capital backing. Nor does the damage end there. The dearth of capital felt by the industries that need to expand is matched by a capital glut in those industries where contraction is equally essential. Thus it happens that by a very human and understandable striving for safety by each investor, the security of all investors is rendered increasingly precarious.

The current tradition of business secrecy also plays its deadly role in this connection. "It may be indeed that we touch here the most fundamental contradiction which threatens the stability of the capitalist system. If the system is to function smoothly, it is necessary—and incidentally, to the interest of every member of society—that adequate information should be available to investors to enable them to direct the flow of savings into the proper channels. At the same time, however, it appears to be to the interest of each individual to prevent potential rivals from having access to that information the absence of which threatens the security of everybody. Self-interest leads every entrepreneur, anxious to protect himself against the risks of competition, to maintain an attitude the general adoption of which is no less to his detriment than it is to the detriment of all his rivals."

Such difficulties as the foregoing were less visible in periods of rapidly increasing population for, with expanding markets for all products, the need of relatively curtailing some industries and expanding others was met instead by differential rates of growth. But now, with the birth rate not much ahead of the death rate, the urgency of growth for some industries and outright decline for others asserts itself with renewed force.

Moreover, inflation and similar tinkerings will not be of aid, for what is essential to meet the need under discussion here is not an altered general level of prices but a flexibility of each price sufficient to facilitate or at least not to block the transfers of capital and labor away from the primary and secondary industries which must shrink, and into the "tertiary" industries upon the expansion of which our continued material progress is so intimately dependent. With this in mind it is possible to picture inflation as particularly futile in that it may obscure the issue and give the appearance of progress in such a way as to lull people into a false sense of imagined security. ". . . there is nothing at all to be said for an [inflation induced] expansion which encourages people to stay where they are when they ought to move away from their customary fields of work."

Professor Fisher withholds his "practical suggestions" until the theoretical analysis has been completed. This is a defensible, logical device but perhaps the purely analytical stress of the first four fifths of the book may alienate many of those "nontheoretical" readers upon whom the moral of the tale might otherwise exercise its most salutary influence. Briefly, these "practical suggestions" may be summarized in a sentence each. (1) The educational system must be oriented to the training of the young primarily in the trades and ways of life of the new expandable "tertiary" industries rather than in those of the older and already somewhat outmoded occupations. (2) The credit mechanisms must be organized so as to facilitate entrepreneurial judgment on the basis of pooled knowledge in place of the current secrecy. (3) The time for organized land settlement is gone. (4) Although the migration of people to be near the sources of raw materials was an essential nineteenth century phenomenon, it is a twentieth century anacronism, for "tertiary" industries can be brought to the people with greater ease than the people can be brought to them. (5) Some investors must be induced to make considerable risks for high rewards or the transfer of capital to the industries that need expansion cannot occur. (6) Entrepreneurs must become once more the eager, profit-seeking, risk-taking business pioneers their theoretical function demands. (7) Small investors must be enabled to take diversified risks through some such technique as the investment trust or their highly important potential backing of the new industries will be lost. (8) The banks must learn to facilitate the flow of savings into the high-risk, high-return, newer industries. (9) In the development of certain of the "tertiary" industries the State may have to play an important role; taxation and deficit paying may be a defensible way of financing public education, health, music, art, and drama. (10) The big research foundations serve a most vital function in withholding income from the people at large and allocating it to the search for knowledge by those presumably best fitted for endeavor at once so difficult and so necessary to the continuance of progress in a society.

In summary, Professor Fisher argues that a progressive capitalism rests on a flexibility of capital and labor which is only achieved by a general willingness to face technical change and on the industrial pioneering of risk-taking businessmen. If these groups, in a demonstrably futile struggle for personal security and an overallegiance to the maintenance of the status quo, refuse to make the essential commitments and undertake the risks attendant on technical change, the result is major economic maladjustment and the cessation of material progress. It may even be that if this trend is maintained for long, the very continuance of capitalism itself is threatened by the chaos that results from a reliance on the change facing, risk taking of capitalists, laborers, and investors, each of whom refuses to make changes or to take risks. If the thirst for security clashes too strongly and too persistently with progress, social disaster threatens.

Problems of Branch Management

(Continued from page 462)

corporation should lay down the broad policies affecting branch management but should leave, as far as possible, the administrative details to the branch management group.

3 It is desirable to have the management group of the branch interested in the earnings of the branch as part of their compensation.

4 The home office must exercise control over capital and development expenditures and set forth general rules to be followed on the extension of credits and inventory purchases.

5 While the home office may advise on employee relationship of the branch, all contacts and policies, as far as employees of that branch are concerned, should be with the branch management.

6 Accounting, sales, and other records must be kept on a standard basis for all branches so comparisons can be made and home-office management be informed of operating results.

7 While there should be constant contact between those in branch management and those in the home office having corresponding functions, final decisions regarding branch policies must clear through the branch manager.

8 Budget forecasting and operation on a budget basis is invaluable in the operation of a branch. The budget for the branch should be prepared by the branch manager and not by the home office.

While there are many other subjects that could be advantageously considered in formulating fundamentals for a successful branch operation, nevertheless, I feel that if the preceding policies are followed, there is a reasonable chance of successful operation. At the same time, adherence to these policies will result in developing responsible future executives for the company and in laying the groundwork for increased efficiency and scope of operation of the branches and of the parent company in the years ahead.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

IN THESE days of crisis and uncertainty an engineer, pondering unexpected ways in which applied science has affected mankind, has cause for real concern. Perhaps he was one of those who imagined, a quarter of a century ago, that had the international telephone been in general use in the days leading up to the World War, the key men of the nations involved could have headed it off with private conversation among themselves. Yet he has lived to see not only the telephone, but radio and the airplane developed to a point where they have become more effective in spreading confusion, misunderstanding, and hatred than in bringing peoples together. He has lived to see, during the last month, one of the greatest democracies of the world forced to resort, in what are euphemistically termed "times of peace," to conscription and to threatened control of profits of industry in time of war. Thus, by a perversion of its ability to free men from the enslavement of their physical environments and the hard bondage of the natural world, applied science is becoming the instrument of destroying individual liberties and of forcing on nations to whom the idea is repugnant the necessity of seeking security through a thinly disguised collectivist glorification of the state at the expense of the man. And engineering itself, recently practiced preponderately in civil life, begins once more to revert to its original service in military objectives.

Throughout the world, and now to an increasing extent in this country, reductions in unemployment and the growth of industrial prosperity must be discounted by making a proper allowance for activity brought about in the name of national defense. Public moneys appropriated for national defense in this country bid fair to rival in amount those that have been poured out during the depression in public works of a more enduring nature and threaten to postpone the long-delayed national recovery of industry and economic stability. Exciting as the times are and as sincerely purposeful as men may be in responding to the call to defend their liberties and ways of life, this diversion from well-ordered progress toward the more satisfying, but less dramatic, goals of a peaceful society is discouraging to men who imagined, a year or two back, that the passion for economic panaceas had been spent and the country was ready to resume the well-tried techniques of intelligence, thrift, and hard work.

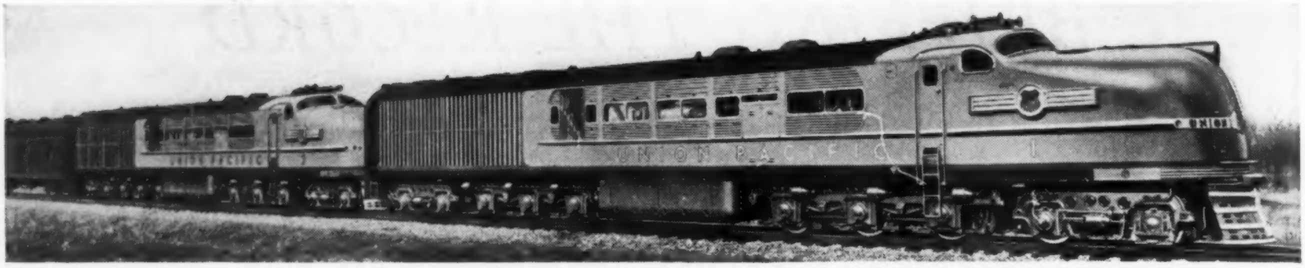
Familiar as the engineer is with the inexorable power of natural forces, he recognizes the futility of defiance. Of control and direction of these forces he knows something. Perhaps he is enough of a philosopher also to recognize a similar power in social, economic, and political forces. Here, too, probably, defiance is futile, but control and direction may be achieved. Water seeks its level, nature abhors a vacuum, and what is resisted in one place may break forth somewhere else. The front pages of newspapers recently told of the grip of miners' unions on the power industry; but the back pages reported a Nobel-prize winner as predicting power from sources independent of the coal mines. Necessity knows no law—and he who attempts to freeze the status quo may find himself left out in the cold. Only change is constant; and as A. G. Christie told the members of the Metropolitan Section of The American Society of Mechanical Engineers at their "Round Up" in April, the "engineers' way out" is to accelerate change. It is more than a way out; it is the way onward, whether of progress as men choose to define it, or of stark fatalism as the Greeks envisioned it, and it must be reckoned with.

A glimmer of understanding may be derived from the generalizations offered by Dwight L. Palmer in his review (see pages 463–464) of the book "The Clash of Progress and Security," by Allan G. B. Fisher. Professor Fisher, it is reported, has conveniently divided man's economic sphere into three productive areas: the production of food and raw materials, the establishment of industries to modify the form and to enhance the usefulness of simpler physical products, and the introduction of industries catering to the whims and luxury desires of men, the output of which is largely personal services. Just as the Old Testament told of the struggles of a pastoral people with a patriarchial form of society to adapt itself to an agricultural life under a monarchial form of government, so, Professor Fisher points out, society in the nineteenth century in Europe and America shifted from the procurement of food and raw materials to the industrial task of modifying the form of these simpler physical products to enhance their usefulness. Today, he contends, we are facing the changes coincident with that further shift to the area of catering to the luxury demand. Thus the pressure of the past always thrusts us on to "new frontiers" where the mode of life is strange and different, but congenial to men with engineering habits of thought.

World of Today

Unsettling influences of threatened war continue to direct the energies of the world of today from productive and peaceful channels and to retard the hoped-for recovery from a long-drawn-out depression. Joining in the race for armaments and for national defense that has been going forward in Europe for several years, this country has voted appropriations of unprecedented amounts, much of which must be spent in industries with which engineers are connected. Late in April the President signed the army appropriations bill and immediately orders for 571 aircraft were placed, first of the 6000 involved in the air expansion program.

The President sent to the Congress in April his reorganization plan No. 1, in which it is proposed, under the authority granted him, to group a number of bureaus and services into three new agencies devoted to security, public works, and federal loans. Of interest to engineers is the Federal Works Agency in which are combined the Works Progress Administration, the Public Works Administration, the Housing Authority, the Bureau of Public Roads, and the Public Buildings Divisions of the Treasury and Interior Departments.



TWO-UNIT 5000-HP STEAM-ELECTRIC LOCOMOTIVE

Appointments of interest include that of Edward P. Warner, to the Civil Aeronautics Authority; Leon Henderson, WPA economist and executive secretary of the TNEC (O'Mahoney Committee) to the Securities and Exchange Commission; and Dr. William M. Leiserson, chairman National Mediation Board, to the NLRB, to succeed Donald Wakefield Smith.

Competing with interest in debated neutrality legislation, discussion of changes in the National Labor Relations Act, in social-security legislation, and in the tax laws has been followed with interest by engineers because of the effects on industry. The magnitude of the taxation problem was emphasized by the recent release of preliminary estimates from a study by the National Industrial Conference Board which showed that in 1938 the share of the national income taken by taxes was 22 per cent. According to the Board, "this represented a tax burden of $105 per capita for the entire population and an average of $317 per person employed." A study of taxation and investment released by the Brookings Institution during April suggested changes in existing taxes on corporation and personal incomes that are designed to stimulate new investment.

Early in April engineers hailed the return to Baltimore of the transatlantic flying boat *Yankee Clipper* after its 11,071-mile trip to Europe, England, and Ireland. The 42-ton plane carried 22 men. Juan T. Trippe, president, Pan-American Airways system, told the Civil Aeronautics Authority that his organization was ready to go ahead with transatlantic service at once.

The *Panama*, said to be the "safest ship in the world," built at the Quincey yards of the Bethlehem Steel Company for the Panama Railroad Steamship Company, started her maiden voyage to Panama on April 27. This new $4,000,000 ship is equipped with steam turbines and mechanical reduction gears, features fireproof materials, and provides quarters for crew that passengers a generation ago would have considered luxurious.

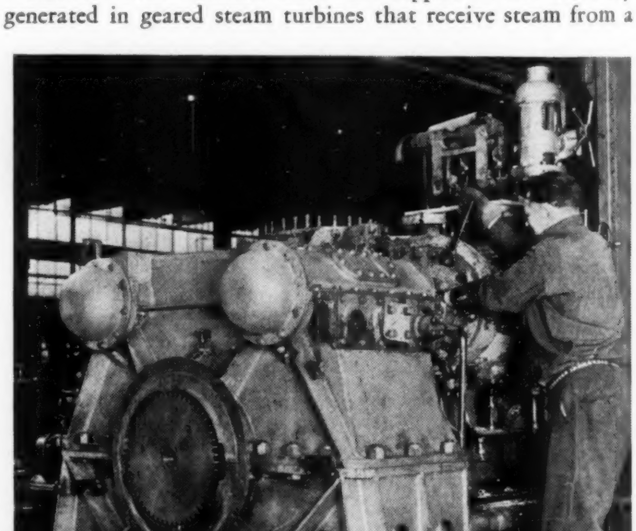
World of Tomorrow

Behind the necessary ballyhoo of publicity which preceded the formal dedication on April 30 of the New York World's Fair, miraculously built under the direction of engineers and architects on the Flushing meadows, lies the promise of the future, the World of Tomorrow. Around the thematic "trylon" and "perisphere," buildings of bizarre design and coloring, transformed at night into multihued masses, house exhibits that should strengthen the faith of men in their ability to create and satisfy new wants. Aside from its commercial and spectacular aspects, the Fair serves one of the most urgent needs of the time, diversion of the public mind from the ills of the world of today by promise of greater things for the world of tomorrow. Such fairs have had important effects on the progress of the nation. Some of them, notably the Centennial at Philadelphia and the World's Columbian Exposition at Chicago, conceived and born in times of dark depression, stimulated men's hopes by showing them what the future held in store, the possibilities of industrial production, and the useful services of electricity. This year, at New York and at San Francisco, the world may discover even greater possibilities for future development. Engineers will share the admiration with which the marvels they have created, will be greeted by their fellow citizens, and will derive inspiration from a personal inspection of both fairs. In September, at the New York World's Fair, mechanical engineers will join with about 200 members of The Institution of Mechanical Engineers of Great Britain in a meeting on the Fair grounds.

Steam-Electric Locomotive

On May 6 several hundred guests of the General Electric Company made a trip from New York to Philadelphia and return on a special train hauled by the steam-electric locomotive built for the Union Pacific Railroad. One of the two units of which the 5000-hp locomotive is normally composed was attached to the train. It is said that with the combined units, each one of which more than 90 ft long, a train composed of 12 standard Pullmans is capable of a top speed of 125 mph.

The six electric traction motors are supplied with electricity generated in geared steam turbines that receive steam from a



COUPLING END OF 2500-HP MAIN TURBINE AND SPEED-REDUCTION UNIT OF THE STEAM-ELECTRIC LOCOMOTIVE ON ASSEMBLY FLOOR

completely automatically controlled boiler that burns oil fuel. This boiler, which was described in MECHANICAL ENGINEERING, December, 1936, pages 771 to 780, generates steam at 1500 psi and 920 F. Exhaust from the turbines is condensed in a finned tube air-cooled condenser. Control of the entire unit is automatically responsive to the engine-driver's movements of a controller handle. Under running conditions electric braking is utilized.

C. F. Hirshfeld

C. F. HIRSHFELD

Few engineers of our day have accelerated and directed the powerful influences of change as skillfully as did C. F. Hirshfeld, who died on April 19, 1939. Few, indeed, have been as intelligently aware of the compelling nature of change or as intellectually curious and diligent in bringing it about through research and the rational approach known as the scientific method as he was. Born and educated on the Pacific Coast, he went to Cornell University in 1903 where he lived for a decade in the invigorating atmosphere so fruitfully stimulated there by Robert Henry Thurston, engineer and researcher in applied science. In this atmosphere unfolded those latent powers of analysis and application that Hirshfeld possessed in such full measure. In 1913 he went to Detroit to organize for The Detroit Edison Company what is thought to be the first research department established and maintained by an electricity supply company. The abundant harvest of his imagination and trained intelligence enriched the public-utility and collateral engineering industries throughout his life. No problem daunted his intellectual courage and resourcefulness. He sought and found truth in obscure places. Traditional patterns did not confuse the designs he wove for the future. His "mind alike conceived and dared;" it was analytical and creative. Among the host of engineering advancements that will be remembered to his credit, one is perhaps typical, the famous P.C.C. car. To modernize the electric streetcar completely from trolley wire to track was a triumph of that engineering approach to practical problems that was so conspicuous in Hirshfeld's work. Nor did his active mind concern itself solely with technical problems. He was devoted to the welfare of the engineer. He served the Engineers' Council for Professional Development as its first chairman. He discussed with intelligence and clarity a variety of economic and social problems and always with that rational approach that was so fruitful in his engineering work. Fortunately, hundreds of men came under the influence of his personality and methods of work. In them his spirit lives, and his work goes on.

Industrial Adhesives

PRODUCT ENGINEERING

MANY new and diversified adhesives have been developed for the manufacture of industrial equipment and the fabrication of products for consumers' use. Manufacturers who have changed their processes by adopting the use of industrial adhesives have found it to their advantage in such vital factors as increased speed of production, decreased labor cost, less machinery, smaller floor-space requirements, and less capital investment, declares John L. Perkins, research engineer, in an article in *Product Engineering* for April, 1939.

In his discussion, Mr. Perkins excludes ordinary pastes, glues, and thermoplastic adhesives which require high working temperature and pressures, because these adhesives have relatively few industrial applications. Pioneered in the furniture, shoe, and rubber-goods industries, cemented assemblies, made possible by the availability of many new types of adhesives, are now widely used in such diverse products as airplanes, electrical equipment, automobiles, ships, printing presses, and novelties.

One important industrial group of adhesives is divided by Mr. Perkins into the following types: (1) Air-drying solvent adhesive compounds containing rubber, (2) air-drying solvent rubber adhesives, and (3) air-drying latex adhesives. Rubber-type adhesive compounds are manufactured for different kinds of uses with various viscosities that range from brushing to putty consistence. They give exceptionally strong adhesion, are waterproof, nonstaining, and permanently resilient. These rubber-compound adhesives solve many cementing problems in industry, and are of immediate interest to many fields of engineering. At present they are used where adhesion to metals, celluloid, rubber, brickwork, stone, wood, plastics, glass, plaster, felt insulation, and leather is desired. Other fields of use for this type of adhesive are found in automotive, aircraft, and shipbuilding industries.

Air-drying solvent rubber adhesives are widely employed in many fields of manufacture. In the production of shoes, these rubber cements are used for cementing channels, sole counters, insoles, and heel coverings. They are also used for upholstery work in automobiles and airplanes. Latex-type rubber adhesives consist of an aqueous suspension or dispersion of extremely small rubber particles. This type of rubber adhesive, as compared with the solvent rubber cement, has certain advantages, such as noninflammability, inherently greater film strength, absence of stringing when sprayed, and greater coverage because of the higher rubber solids. Besides being used in the shoe industry as much as solvent rubber cements, this adhesive also finds uses in the lamination of paper and the bonding of materials, such as cork, fabrics, rubber, fiberboard, and hair bristles in brushes.

A second industrial group includes some recently developed adhesives which have many technical applications. These cements can be subdivided into the following classes: (1) chloroprene adhesive, (2) thermosetting chlorinated rubber and chloroprene combination, and (3) thermosetting cyclized rubber chloroprene adhesive. Chloroprene adhesive has the desirable property of withstanding the deteriorating action of oils, gasoline, and other solvents, in addition to its superiority to rubber adhesives in natural aging, sunlight resistance, and tensile strength. These advantages make it especially suitable for bonding leather to leather, rubber to leather, and rubber-like synthetic products to other materials. Thermosetting chlorinated rubber and chloroprene combinations are recommended for bonding with heat, at 280–300 F, synthetic rubber-like materials, such as chloroprene, butadiene, and alkylene polysulphide polymers to metals. Some of the technical applications include the manufacture of composite products, such as molded chloroprene parts with metal inserts bonded strongly into them, the attachment of oil-resisting cable sheaths to wire cables, and the bonding of chloroprene to metal for absorbing vibrations, deadening noise, and electrical insulation. Thermosetting cyclized rubber chloroprene adhesive is used with a heat cure for bonding rubber to metals and various types of alkylene polysulphide polymers to other materials. The applications

are similar to those of the previously described adhesive, such as bonding rubber linings to steel-tank interiors.

Cellulose ester adhesives are a third industrial type which has a wide range of applications. Part of the reason for the adoption of this type is its excellent adhesion and inherent waterproofness, oil resistance, and low cost. One of the largest applications of cellulose adhesives is found in the shoe industry which uses pyroxylin cements for attaching soles as an alternative to the time-honored stitching method. Shoes made in this manner are equally durable and cheaper to manufacture. In 1938 more than 90,000,000 pairs were made in this fashion.

New Lamps and Applications

A.S.M.E. TEXTILE MEETING, GREENVILLE, S. C.

LAMPS, their development and application, was the subject of the paper presented by G. E. Park, General Electric Company, at the morning session of the Textile Meeting in Greenville, S. C., April 5, 1939, which was held under the joint sponsorship of the Textile Division and the Greenville Section of The American Society of Mechanical Engineers. Natural daylight or ordinary artificial light is composed of different wave lengths, or bands of color, known as the spectrum. According to their relative wave lengths, they are identified as violet, indigo, blue, green, yellow, orange, and red, and comprise the visible portion of the spectrum. Other wave lengths, ultraviolet and infrared rays, are too short or too long to be visible to the human eye.

Special lamps have been developed to generate waves of these various lengths, such as the ordinary infrared or heat-ray lamp which generates some visible light, but predominates in infrared rays. These are useful in many ways, such as penetrating deep into human flesh to relieve sore muscles and similar complaints. The latest development in this field is a 250-watt lamp designed for and patented by the Ford Motor Company. The heat lamps in gold-plated reflectors, thousands of them, are arranged in tunnels, and the automobile bodies travel through on overhead conveyers, as shown in Fig. 1. The method is so efficient that the primer coat is baked in 15 min instead of the hour formerly required when steam ovens were used. This speed is the result of using infrared rays which penetrate the primer coat and heat the metal underneath, which in turn dries the primer coat rapidly from the inside.

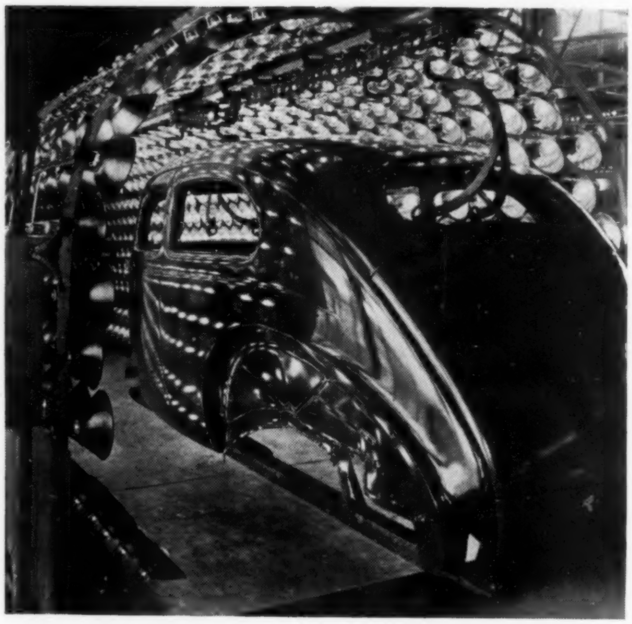


FIG. 1 BAKING PAINT ON FORD AUTOMOBILE BODY BY PASSING THROUGH A TUNNEL OF INFRARED-RAY LAMPS IN GOLD-PLATED REFLECTORS

Likewise, other lamps generate a preponderance of ultraviolet rays. These are capable of providing mankind with certain therapeutic benefits, but are too short to be visible to the eye. New lamps generating rays of special types have been developed in this region, such as the sterilamp, useful in hospital operating rooms and other locations for reducing bacterial count. Westinghouse Electric and Manufacturing Co. has brought out a special ultraviolet lamp to be used in tenderizing steaks and meats.

Regular types of Mazda lamps produce rays falling into all three classes: Ultraviolet, visible, and infrared. The unfortunate factor here is that only a small portion falls into the visible range, the other rays falling into the invisible portions of the spectrum, and hence being of no value for purposes of seeing. The problem then has been to convert some of these rays from the invisible into the visible portion of the spectrum. This may be accomplished by shortening those which are too long, or by lengthening those which are too short. So far, very little has been accomplished to shorten the infrared rays; however, the research laboratories of the General Electric Company have been able to lengthen ultraviolet rays. The research engineers found that when ultraviolet rays shine upon certain chemical powders, these powders, called phosphors, glow or fluoresce, and transform the ultraviolet rays into visible light.

As mercury lamps are rich in ultraviolet radiation, they were chosen to supply the rays for the new fluorescent lamps. The lamp consists of a glass tube, with an electrode at each end, and filled with a small amount of mercury and neon gas. When current is turned on, the electrodes are heated, causing them to give off electrons, which in turn causes an arc to strike between the two electrodes. This arc consists of a small amount of visible light, and a relatively large amount of ultraviolet rays. By coating the inside of the tube with the phosphor powder, ultraviolet light is transformed into visible light. By simply varying the chemical composition of the phosphors, light of any color or tint may be produced. Green is the brightest and red the least bright. Fluorescent lamps, being very efficient, use little current and are cool to the touch.

Sampling of Air Impurities

AIR HYGIENE FOUNDATION

BEARDS as a preventive of silicosis are mentioned in a bulletin, "Routine Sampling for Control of Atmospheric Impurities," prepared by the Air Hygiene Foundation's preventive engineering committee, headed by Prof. Philip Drinker, of Harvard University, and just issued by the Foundation to its 250 member companies and associations. Citing British silicosis authorities on the incidence of the disease in relation to the hirsute adornment of the face, it is shown that among stonecutters erecting huge masonry structures in a dusty atmosphere, clean-shaven men suffered most from silicosis. Men with mustaches fared much better and men with full bushy beards and mustaches were practically immune.

These results are in line with the tests made by the committee which show that the nose is an inefficient sieve to screen out dust particles from the lungs. Therefore, it is necessary to check the air of a workplace so that the resulting data can then

be applied to the design of control equipment or to checking the results brought about by such equipment. This check may be accomplished in two steps, first, measurement of air currents, and, second, estimation of impurities.

In the case of all dusts the estimation of the sample taken from the air can be made by counting representative fractions under the microscope, or the sample can be analyzed by appropriate chemical methods, or the material can be weighed. The large impinger apparatus and the electric precipitator are equally well adapted to either procedure. The midget impinger collects, in reasonable sampling time, a relatively small amount of dust, but enough for counting. Dusts, like silica, that are troublesome to determine chemically, are generally counted while those like lead, manganese, and cadmium, are determined chemically.

Some gases and vapors, notably carbon monoxide, hydrogen sulphide, and mercury, in minute amounts, give strong chemical reactions which make possible rapid estimations and, still better, continuous records of pollution. However, the great bulk of gases and vapors from organic solvents, such as benzene, carbon tetrachloride, and carbon disulphide, cannot be caught efficiently unless sampled at slow rates, such as $^1/_2$ to 1 liter per minute. Some of them, such as benzene, can be absorbed directly in special solvents or adsorbents, like charcoal or silica gel, or can be converted into another compound which can then be estimated by an appropriate method.

The greatest difficulty in estimating organic vapors in air occurs when mixtures of vapors are present. Unfortunately, this is all too often the case. Then, the devising of short cuts in itself offers a major problem, but local conditions permit the approximations of the proportions of the several ingredients in the collected sample and calculation of the total by estimating only the most easily determined single constituent.

Samples should be taken wherever men work. It is a mistake to ignore places where one believes that there is no dust or gas. The samples are about the only proof that the employer can bring forth that he has taken proper precautions to prevent a disease, such as silicosis or a chronic poisoning from benzol. It is well to play safe and to take them too often rather than too seldom.

New Photoelasticity Method

ENGINEERING EXPERIMENT STATION NEWS, THE OHIO STATE UNIVERSITY

INVESTIGATING stresses in three dimensions by optical methods, similar to those employed for photoelastic studies in two dimensions, has been done by loading a plastic model at about 230 F, cooling it under load to preserve the distortions, and then cutting out a slice which is examined for stress patterns showing how the loading was carried in the part. Now, a new method, using a light to "slice" the model, has been developed according to a note in the April, 1939, *Engineering Experiment Station News* of The Ohio State University, by Royal Weller, member of the station, who described it in detail at the Eastern Photoelastic Conference at Cornell University, May 13.

Making a transparent model of the part to be studied out of bakelite or other suitable material, the investigator places any part of the model under stress equivalent to that experienced by the actual piece in use. The model is surrounded by oil of the same optical properties as the model itself, because otherwise the "slicing" beam would be bent or deflected in passing through the object. Then the light is focused on any part of the model, which may be "sliced" by the light beam in any desired direction and studied immediately by eye or photographed for permanent record. Scattering of light by the model itself in directions at right angles to the original beam produces a visible pattern, indicating the stresses which may be expected in the actual full-size part under corresponding conditions. With the load removed, the model remains intact for any future use.

The advantages of the new method, according to Mr. Weller, are:

1 No actual slicing of the model is necessary. The light beam may be used to "slice" the model in as many directions as desired and, hence, no distortion of the pattern results from cutting operations and the model is not destroyed by the test.

2 Heating and cooling are not required, and the uncertainty in physical constants thereby introduced is eliminated, together with the necessity for furnaces. Large deflections do not occur, enabling the use of the theory of superposition with confidence by the investigator.

3 Differential fringe patterns may be observed, eliminating the errors introduced by unknown initial conditions.

4 Stress directions and principal values may be obtained by rotating the model while observing it, thereby eliminating the very complex analysis necessary with a sliced model.

5 Loading and unloading may be repeated as often as the observer pleases, enabling observation of the way in which the stress patterns form and enabling checks and duplicate readings to be made.

Steam Versus Diesel-Electrics

SCHOOL OF ENGINEERING, YALE UNIVERSITY

TALKING before engineering students at Yale University on March 8, L. K. Sillcox, member A.S.M.E. and chairman of the Professional Divisions Committee of the Society, gave an evaluation of the economical and mechanical characteristics of steam and Diesel-electric locomotives. He showed how 17 barrels of oil in a Diesel-electric locomotive will haul a high-speed, de luxe train at 80 mph, nonstop, from New York to Boston, while the same quantity of fuel oil fed into the firebox of a steam locomotive will take the same 12 heavy cars only as far as Bridgeport, Conn. This is a 4.5 to 1 advantage in favor of the Diesel. It represents the improvement in over-all thermal efficiency secured by the direct combustion of oil above the piston of the Diesel engine as compared with its atomization within a locomotive furnace, the evaporation of boiler feed-water, and subsequent expansion of steam in two simple cylinders of large dimensions.

However, locomotives are not selected on the basis of thermal performance alone. The high initial cost of the Diesel-electric locomotive is one of its chief disadvantages. Another is that it is not adapted to burn coal, and there are pronounced territorial influences on the relative fuel costs. The personnel and facilities for the maintenance of steam locomotives, highly proficient in all familiar operations, often prove awkward and incompetent when called upon to transfer their skill and adapt their physical routines from boilers, grates, 1500-lb rods, and 80-in. wheels, to crankshafts, fuel-injection systems, timing mechanisms, electric generators, and traction motors. In other words, the steam locomotive still maintains an inherent simplicity.

Typical heat balances of the two types, when permitted to operate at rated capacity, distribute the calorific value of the fuel as shown in Table 1. A vast amount of research and experimentation will be required to narrow the margin of relative fuel utilization of the two motive-power types. The steam locomotive still predominates in road service despite its short-

TABLE 1 COMPARATIVE HEAT LOSSES OF STEAM AND DIESEL ENGINES—PER CENT OF TOTAL HEAT IN FUEL

		Steam	Diesel
Boiler:			
Radiation	3.3		
Unburned coal	16.3		
Carbon monoxide	0.6		
Heat in smokebox gases	11.1		
Total losses		31.3	None
To auxiliaries		3.3	2.5
Cylinder radiation, throttling, etc		5.8	1.6
To jacket cooling water		None	33.2
Available heat in exhaust		51.7	24.2
Machine friction		1.2	10.6
Recovered and developed as useful work:			
Drawbar horsepower		6.7	27.9
		100.0	100.0

TABLE 2 COMPARISON OF SERVICE HOURS AND OPERATING COSTS OF STEAM AND DIESEL-ELECTRIC SWITCHING LOCOMOTIVES

	Steam	Diesel
Service comparisons		
Service hours per year	4650	6500
Equivalent availability, per cent	53.0	74.2
Basic fuel costs		
Coal, per ton on tender	$1.63	..
Oil, per gallon on locomotive	..	$0.042
Service costs per hour of operation		
Fuel	$0.820	$0.296
Water	0.036	..
Lubrication	0.020	0.044
Repairs	0.725	0.535
Enginehouse expense	0.505	0.016
Other supplies	0.024	0.024
Wages, two men	1.490	1.490
Total	$3.620	$2.405
Relative investment per unit		
First cost, typical	$41,000[a]	$70,000[b]
Fixed charges on equivalent service-hour basis		
Depreciation at 4 per cent	$0.353	$0.436
Interest at 5 per cent	0.441	0.790
Insurance and taxes at 2 per cent	0.177	0.316
Total	$0.971	$1.542
Total hourly cost (service costs per hour of operation plus fixed charges on equivalent service-hour basis)	$4.591	$3.947
Ratio of net cost—Diesel to steam	0.862	

[a] Estimated for 1939—Steam switching locomotives of study actually cost $22,000 in 1918. Strictly modern units would be more economical in fuel and water.

[b] Estimated for 1939—Diesel-electric switching locomotives of study actually cost $102,700 each in 1930.

comings in this respect. Practical considerations will make it difficult to broaden the temperature range in which the Diesel operates, since it already approaches practical attainment of its Carnot efficiency equivalent. The steam pattern must be vastly improved to display a similar degree of efficient utilization of heat. It is a severe limitation of the steam locomotive that the vast temperature range between firebox and exhaust steam cannot be utilized by any known system of generation.

As mentioned before, on an equal rated horsepower basis, the Diesel costs three to four times as much as a comparable steam design. In switching service, however, half the installed Diesel capacity will serve more efficiently than the full complement of power in a steam equivalent. The reason for this is that the Diesel engine, supported by an electric transmission, is enabled to deliver its full rated power to the generator shaft at all locomotive speeds. The torque of the traction motors in starting and at low speeds is only limited by the motor characteristics, the capacity of the motors to receive high current input without damage, and, by the friction between wheel and rail, to support the wheel reaction without recurring slippage. A steam locomotive is limited in its maximum starting torque, first, by rail friction, and, second, by the torque delivered by steam pressure on a piston of fixed dimensions.

For all switching speeds up to 6 mph, a 1200-hp Diesel-electric locomotive delivers higher torque and thus can accelerate maximum tonnage more rapidly than can a steam locomotive of 2100 hp. Its superiority over a steam locomotive of 1500 hp extends to 7 mph, and over a 1300-hp steam locomotive, to 11 mph. Corresponding Diesel advantages at low speeds over steam characteristics in much larger locomotives are apparent both in 900- and 600-hp Diesels. Most close switching is accomplished with 6 mph seldom exceeded. Comparison of service hours and operating costs of steam and Diesel-electric switching locomotives of an eastern railway are shown in Table 2.

It was ten years after acceptance of the Diesel-electric locomotive in switching service before a railway found justification for an experimental Diesel installation for use in hauling high-speed passenger trains. Since then Diesel-electric locomotives have been used on many lines. A compilation of data accumulated from the offices of various railways shows operating expenses, wages, fuel, water, lubricants, maintenance, train supplies, and enginehouse expense for the Southern Pacific steam-hauled *Sunbeam* to be 80 cents per train-mile, compared with 62 cents for the Diesel Denver *Zephyr*'s of the Burlington. These trains have similar passenger capacity, but the daily mileage obtained from each Diesel is four times that required of each Southern Pacific steam locomotive. Other comparisons substantiate these figures.

Then, too, availability must be considered. The steam locomotive which demonstrates 65 per cent availability is exceptional, due, in no small measure, to lack of incentive to improve the record. This is compared with proved Diesel availability of 95.4 per cent for all Burlington Diesels from their dates of installation to July 1, 1938; 84.6 per cent for the *Green Diamond* of the Illinois Central for the year ended July 1, 1938; and 98.5 per cent for both *Rebel* trains of the Gulf, Mobile & Northern over the same period. Such intensive use goes far toward justifying high initial cost.

Confronted with conflicting necessities for providing a long piston stroke, but limited piston speed, the locomotive builder is compelled to look to increasing driving-wheel diameter as the only means whereby high speeds practicably and efficiently may be operated. But, then, the barrel of the boiler rises to keep clear of the higher wheels which in turn raises the center of gravity of the entire structure. The Diesel, offering complete latitude in the placing of equipment in the cab, in so far as operation is concerned, has the engine and generator low in a subframe. The traction motors are upon the trucks. The center of gravity of the Diesel-electric locomotive is 24 to 30 in. lower than that of an equivalent steam locomotive.

The gear-driven wheels of the Diesel have no concentrated weights. They are symmetrical about all axes, and produce no dynamic augment. Consequently, slipping of wheels is both less common and of less consequence. However, high-speed steam-locomotive designs of the future will require less weight in the counterbalances of driving wheels to neutralize nosing than has heretofore been the practice. Dynamical vertical effects will be reduced in proportion and a serious objection to steam locomotives for high speed, an objection from which the Diesel-electric can claim complete freedom, will be overcome.

The locomotive is less effectively braked than the cars which it hauls. Thus, locomotives are responsible for lengthening stopping distances of trains. There are three reasons why the

steam locomotive has never been adequately braked as judged by car-braking standards. Fully efficient brakes on the guiding trucks have been avoided, because it has been felt that their application would interfere with guiding action and, thus, with safety. Driving wheels have not been heavily braked, since it is held that the heat developed in braking would loosen tires and introduce a hazard from that source. Locomotive tenders have not been adequately braked under operating conditions of partial to full complement of coal and water, since design contemplates possible heavy braking with supplies nearly depleted. Wheels beneath the Diesel-electrics constructed up to this time are of small diameter, car-type, and wrought-steel pattern. Then, too, Diesel-electric locomotive light to full-load weight variation is much less than corresponding differences in steam locomotives and tender combinations. In fact, it has been unnecessary to respect this weight change in Diesel practice, because of the inability to fit brakes to heavily loaded Diesel wheels which, within established limits of permissible shoe pressures, will produce retardation rates as high as those of which the cars are capable.

Temperature-Indicating Paints

ZEITSCHRIFT DES VEREINES DEUTSCHER INGENIEURE (GERMANY)

UTILIZATION of specially selected temperature-indicating paints, or "thermocolors," which undergo a distinct change in color at certain fairly definite temperatures, has aided research engineers of the I. G. Farbenindustrie, A.-G., Oppau, Germany, in the design of air-cooling vanes and baffles for airplane engines, according to a paper, by F. Pensig, engineer, in the Jan. 21, 1939, issue of *Zeitschrift des Vereines deutscher Ingenieure*. This new method, with further development, should prove economical in most cases where thermocouples are now used to indicate temperature change and distribution of the part being tested.

Thermocolor paints have already been known, and, in fact, have been applied to machine bearings, to indicate rise in temperature, especially in cases where timely and visual warning of such increase in temperature was desirable. The pigment base principally used in these earlier paints consists usually of double iodides of mercury and copper, or mercury and silver. Such paints, however, can only be used for comparatively low temperatures, not exceeding 150 F, and the color change is not permanent, but usually reverts to the original color on cooling.

For the present work, the conditions were more exacting, says Mr. Pensig, with temperatures over 750 F being involved. It was absolutely essential that the color change should be permanent, and should also be sharp and definite at the specified temperature within a small margin of error, such as ±40 F. More than 300 different materials were investigated and only a very few were found suitable. They are mostly metallic salts, but their composition is not disclosed by the author in his paper, the different types being designated by number, as shown in Table 3, together with the color changes and appropriate temperatures.

In Table 3, numbers 20, 30, and 31 represent multicolor paints, or those indicating more than one temperature change. These have been prepared from specially selected materials, or by combining two or more monocolor paints. It is claimed for these that they are very useful for indicating temperature distribution over a comparatively wide region. The time factor is important and, noticeably at the higher temperatures, the actual temperature indicated is somewhat lower after prolonged exposure to heating. Details of the variation, including curves showing relation between time of exposure and temperature recorded, together with colored photographs of the application of the paints and other data are included.

TABLE 3 COLORS AND TEMPERATURES OF THERMOPAINTS

No.	Color change	Temp F
1	Rose to blue	90
2	Light green to blue	140
3	Light yellow to violet	230
4	Purple to blue	280
5	White to greenish brown	350
6	Green to dark brown	430
7	Yellow to reddish brown	555
8	White to light brown	645
9	Violet to white	825
20	Light rose (pink) to light blue	120
	Light blue to light brown	290
30	Light green to light blue	120
	Light blue to olive green	290
	Olive green to grayish brown	430
31	Brown to grayish brown	310
	Grayish brown to greenish brown	450
	Greenish brown to reddish brown	530

Although the thermocolors shown in the table indicate color changes at the different temperatures given, it is pointed out by Mr. Pensig that, in the case of numbers 1, 2, and 3, these changes are not stable in the presence of moisture. For use under wet conditions and at these lower temperatures, recourse is had to the lower grades of the multichange colors, numbers 20 and 30. Attempts are being made to evolve colors of the single-change type which will show stable or permanent color changes under moist conditions to take the place of the existing numbers 1, 2, and 3.

An interesting part of the work was the discovery of a suitable binder or medium for the pigments. This was ultimately found in a synthetic resin soluble in alcohol. The resin, in finely powdered form, is mixed with the pigment and stirred up with sufficient alcohol to yield a paint of the right consistency, either for application by brushing or by spraying. The alcohol immediately evaporates, so that the paint dries very rapidly, and the resin is stable at high temperatures, does not in any way affect the color changes, and insures good adhesion at the higher temperatures.

Aircraft Accidents

U. S. CIVIL AERONAUTICS AUTHORITY

THE FOLLOWING conclusions relating to air carrier service are quoted from "Aircraft Accidents and Casualties," Civil Aeronautics Bulletin No. 3, of the U. S. Civil Aeronautics Authority:

From the reports available on European flying activities for 1936, the safety of air travel on air carriers of the United States appeared then to be nearly two and one-half times greater.

The number of passenger-miles flown yearly has increased from 84,000,000 in 1930 to 188,000,000 in 1934 and to 550,000,000 in 1937.

Under causes of accidents in this class of flying, the pilot errors are chargeable about equally to errors of judgment, poor technique, and carelessness or negligence.

Material failures have decreased since 1932 and power-plant failures decreased appreciably in 1936 and 1937.

Miscellaneous causes are traceable largely to weather conditions, with airport and terrain next in order.

The number of forced-landing and landing accidents has decreased appreciably during the last five years; there has, however, been an increase in the number of taxiing accidents.

The miles flown per fatal accident have increased from 890,000 in 1928 to 6,000,000 in 1933 and 12,800,000 in 1937.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Electric Locomotives

To the Editor:

While recognizing many of the inherent advantages of the electric locomotive, as cited in Mr. Cain's interesting paper,[1] it is evident that the electric locomotive is available only in electrified zones, while self-contained Diesel or steam units are more universally available. Also the higher initial cost of electric locomotives, combined with the cost of transmission and other main-line equipment, largely confines their use to tunnels, or the more densely populated districts where increased traffic, elimination of smoke, and their more rapid acceleration, recommend or will support the greater investment.

As to the utilization of power at all speeds, motive-power transfer, adhesion, and riding and guiding qualities, I beg to suggest the following:

The low percentage of power-transmission loss in the steam locomotive, together with the more universal use of roller bearings and alloy-steel reciprocating parts, largely overcomes the greater friction losses.

The present trend is to build steam locomotives suited to high-speed passenger-and-freight service, so that the increased momentum largely overcomes the speed losses over the ruling grades and in turn facilitates pooling over a wide range of roadbed, with a substantial reduction in the number of units used.

Authorities agree that adhesion decreases with speed increase and, therefore, with a satisfactory adhesion factor at the lower speeds, the tractive-power curve must closely follow the adhesion curve as speed increases, so as to obtain the minimum slipping tendency.

The single-ended through-frame construction with multiple-wheel assembly of leading truck, drivers, and trailing truck, if provided with cushioned lateral-motion resistances such that those at the forward end largely overcome those at the rear end, will best absorb the centrifugal and other curving forces and guide the locomotive more smoothly and safely through curves at higher speeds than will any form of double-ended construction.

It must be recognized that the intermediate drivers and the front axles of a radial trailing truck are weight-carrying units only, each of which should be provided with low self-centering lateral-motion resistance mechanisms just sufficient to maintain them in central position on tangent track.

It is interesting to observe that, when the intermediate driving axles and the front trailing axles are thus equipped so as to allow their flanges to float freely against the rail on curves and when a high-resistance lateral-cushioning device is provided on No. 1 drivers with an increasing cushioning resistance on the leading and trailing trucks, the flange pressures will cause each axle of the locomotive to deflect in the opposite direction from that caused by journal load, thus contributing longer axle life for every axle in the locomotive.

The leading truck is the most effective guiding element of the locomotive and its lateral-motion resistance mechanism should be such as to offer an increasing resistance through the first inch or two of lateral movement and thereafter a constant resistance throughout its full moving range. The trailing truck, being less effective, should be provided with a lateral-movement mechanism having the same characteristics but with just sufficient initial resistance to prevent vibration on tangent track.

The building up of these resistances from a low initial to the constant value provides the cushion when entering a curve and at the same time gives the equivalent effect of passing a curve of much longer radius.

Next to the trucks, the front driving wheel is most effective for guiding and should have a cushioning device giving increasing resistance with lateral movement and having sufficient moving range to maintain it in spring suspension throughout its entire lateral displacement. This wheel so equipped equalizes its flange pressure with the leading truck, and their sum provides the entire guiding resistance at the front end thus preventing a wheel-bound condition on all main-line operating curvature between the driving box and wheel flange, such as results when no lateral-cushioning mechanism is used.

The total effective guiding resistance of a locomotive on any curve is the difference between that at the rear trailing wheel and that at the leading end, comprising the leading truck and No. 1 driver.

The aim of this discussion is to indicate the most favorable riding, guiding, rail- and locomotive-stress conditions over the entire range of main-line operating contours.

It follows that all tires should be set $53^{3}/_{8}$ in. apart, so as to effect the utmost in guiding by having each wheel flange bear against the rail on curves, with a minimum lateral sliding across the rail.

Following these principles of design, there seems to be no better type than the articulated locomotive for fast-freight and passenger service when more than four driving axles are required to obtain the desired tractive power. Any locomotive with an odd number of driving axles over three is objectionable because it is difficult on curves to obtain wheel-flange contact with the rail of the middle pair, and the unbalanced wheel and rail reactions caused thereby are troublesome at all speeds.

It is equally desirable to apply a flexible spring suspension to eliminate the vibrations caused by uneven track and yielding rail joints traversed by each individual wheel, and to control the vibrations initiated by these and other disturbing forces.

It should not be overlooked that with this improved guiding and more flexible spring suspension, a higher average and more uniform speed can be maintained when negotiating curves and grades, making it unnecessary to reach as high speeds after passing them to maintain the required average speed. Furthermore, fewer brake and sand applications are necessary before entering curves, resulting in less slipping of driving wheels.

The principles of flexible lateral guiding resistance and vertical flexibility, therefore, give promise of accomplishing more in the way of reducing stress in both right of way and the locomotive, maintaining a more uniform weight distribution, increasing speeds, reducing weight, decreasing track and locomotive mainte-

[1] "Electric Locomotives," by B. S. Cain, Mechanical Engineering, November, 1938, pp. 829–833.

nance, improving the riding qualities, and increasing the safety of operation than seems otherwise possible, until the welded rail now being developed becomes a further universally accepted means of doing for the railways what the improved highways of today are doing for the automotive industry.

Much research work has been done and ingenious mechanisms devised for determining the lateral rail stresses produced by the individual wheels, but unless steps are first taken to control, equalize, and reduce to a minimum the defects in locomotive design which produce these stresses, little, if any, advance of a helpful nature will result.

There is undoubtedly a substantial field for each of the types discussed. Each has its inherent advantages and disadvantages and the intensive research now at work promises many improvements.

J. G. BLUNT.[2]

TO THE EDITOR:

Mr. Cain deserves to be highly congratulated upon his interesting paper. In general, any differences of opinion which I may have are of a minor character, and do not merit discussion. However, the paper brings out a few salient features which warrant further emphasis, and my remarks are confined to these factors.

Mr. Cain's tabulation illustrates the marked improvement which has been made in electric locomotives, but this tabulation does not show the proper comparison with other types of power. Unfortunately in many ways, electric locomotives have always been rated in continuous horsepower which is a poor measuring stick of their serviceable capacity, as their inherent overload capacity can always be used to a greater or lesser extent depending upon the profile and service.

The writer has always contended that electric locomotives should be given a further rating based on the average available output from say 40 to 100 per cent speed. This available capacity will, on modern units, average about 50 per cent higher than the normal continuous rating. On this basis, a comparison of the weight of the electric locomotive with those of other types of power is illuminating as shown in Table 1.

TABLE 1 WEIGHTS OF LOCOMOTIVES

	Pounds per hp
Diesel-electric	190–200
Steam, including tender	150–160
Electric	50–60

Thus it can be seen that the electric locomotive is still far superior to any of its competitors, and this superiority has brought about what Mr. Cain refers to as the third phase of electrification development "in which electric operation cannot be equaled by any other form of motive power" for "main-line heavy-schedule train operation."

One of the ways in which the overload capacity of the electric locomotive has been used to great advantage was pointed out by Mr. Cain in his reference to momentum grade operation of freight trains. This type of operation is becoming quite general with steam as well as with electric locomotives. However, in order to take full advantage of this operation, it is essential to have locomotives which can maintain high short-time outputs at speeds up to 50 mph. It is common practice today to set electric-locomotive tonnage ratings calling for the maintenance of running adhesions of 20 per cent at speeds up to 50 mph, and even when working the locomotives to these high limits, we are not encountering any trouble from stalled trains. In some cases, by this practice, we have been able to double the train handled by a single locomotive.

In this connection, Mr. Cain's references to adhesion limits are quite interesting. Before the advent of the modern high-capacity electric locomotive, there existed no locomotive which could deliver from 20 to 25 per cent adhesion at relatively high speeds. Today we have locomotives which can do this and find it practical to use them at these limits.

In closing, I wish to emphasize what, to my mind, is the greatest advance in the electric locomotive, namely, its ability to operate interchangeably in either freight or passenger service. It is most likely that the electric locomotive of the future will be a universal locomotive which can be used freely in any manner without any restrictions upon its operation.

CHARLES KERR, JR.[3]

TO THE EDITOR:

In defense of the reciprocating steam locomotive and in an effort to establish the practicable limit of short-period high ratings of electric locomotives, I would refer to the author's statement to the effect that "a locomotive which rates 5000 hp continuously can develop something like 10,000 hp for short periods." The statement is accurate but the extent to which the normal rated horsepower temporarily can be increased and usefully applied is sometimes much more generously stated, justifying inquiry into the penalty in electric-locomotive weight and cost which may be suffered to provide high short-period ratings. Since temperature rise in the motor armatures is one element which restricts the amount and duration of permissible overload, it is evident that any effort to secure this advantage by liberal design involves some added expense.

The steam locomotive may also be designed to provide an equivalent overload capacity by increasing boiler size with respect to cylinder dimensions. A larger boiler, used in conjunction with cylinders and running gear of given ratios, will permit an increase in cutoff with correspondingly augmented horsepower development at any stated speed. Similarly steam locomotives are rated at the most economical firing rate, normally from 100 to 120 lb of bituminous coal per sq ft of grate area per hr. Under forced operation, this may be increased to from 250 to 300 lb with an increase in power development obtained at the cost of reduced furnace and boiler efficiency. It is, however, a practicable way of obtaining temporary high rating to meet a specific situation. The duration of such overload is not limited by the capacity of the locomotive to sustain it but by economic considerations alone.

It clearly is not intended to suggest the practicable possibility of building into a steam locomotive, for a specified service, twice the rating which practice would normally provide, much less attempt to duplicate the much higher short-period ratings sometimes claimed for electric designs. It is suggested that, if these high overload characteristics of electric patterns are obtainable only at greatly increased locomotive cost, it might be as practicable to secure their equivalents with steam.

The author has investigated adhesion (rail-friction) values by applying high driving torque to the wheels of electric locomotives at advanced speeds, observing the points at which slippage occurs. Corresponding tests have been conducted during braking, measuring the retarding torque or merely the retardation rate experienced without wheel sliding or at the point of wheel slippage.

Three factors must be borne in mind in the interpretation of such results. First, one or the other of two wheels, having coned treads, and fixed to a common axle, must be creeping with respect to the rail almost all of the time on curved or tangent track. Wheels do not run for any extended period of time on equal diameters. Second, as long as wheels are permitted to roll freely on the rails, their contact is basically static (excepting the condition of creep just described)

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[3] Transportation Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

and there is thus no reason for expecting a change with speed in the absolute adhesion or friction values. Third, adhesion tests normally do not measure adhesion at all, but measure the instantaneous product of the coefficient of adhesion or rail friction and the instantaneous weight on the axle investigated. Vertical dynamic effects increase with speed and the momentary weight transfer due to track irregularities likewise increases with speed. Thus, when adhesion values are sought, employing the static weight for the weight factor in the equation, there is an apparent diminution in the coefficient of adhesion which may be grossly misleading. There is nothing in tests with which I am familiar to substantiate the view that any decrease in the absolute coefficient of rail friction occurs as speed increases.

It is also interesting to speculate on the effect of spring characteristics upon the tendencies toward wheel sliding during braking. The harmful effects of poor track surface, associated with a tightly compacted rigid track support, are well known. A relatively resilient spring suspension system will prevent extreme variations in intensity of instantaneous loading but produces weight-change cycles of relatively long period. On the other hand, a rigid suspension system will cause marked variation in instantaneous loading, passing through maximum and minimum values in rapid succession. A wheel-and-axle assembly, representing a substantial amount of rotative inertia, requires a definite and measurable period of time in which to alter its speed over any considerable range. There is still unanswered the question as to the relative tendencies to slide as influenced by the wide limits of instantaneous weight variation due to stiff springs, and by the longer period of reduced rail pressure which resilient springs provide.

A. W. LAIRD.[4]

TO THE EDITOR:

I have only two points to make: The first applies to Mr. Cain's positive statement that "the concentration of power permits increased speed and acceleration of heavy trains which is difficult to equal by other means;" and second, to the riding qualities of electric locomotives as compared with steam.

The first statement is correct, but with certain qualifications. The locomotive must have behind it a concentrated power, which, as given in the paper, is sometimes twice the power of the locomotive itself (10,000 hp over a short period for a 5000-hp locomotive); in other words, a 5000-hp locomotive is dependent upon a power coming from an outside source of about the same magnitude. This, of course, costs money.

In the example sketched in Fig. 1 of the paper no exact figures are given and, therefore, it does not prove the statement, especially in high-speed passenger service. The steam horsepower curve after the intersection at a high speed, the magnitude of which is not indicated, continues on the graph to stay higher than the electric horsepower, and as the latter has a drooping tendency, the advantage at high speed is not obvious. If the steam train continues at that high speed for a sufficiently long period of time, the time gained at high speed may offset the advantage of acceleration at lower speed, and thus the average speed with steam may be higher.

Furthermore, this comparison is made for electric locomotives and steam locomotives of approximately the same power at high speed. For proper comparison the cost of those locomotives, including for the electric locomotives the pro rata cost of electrification, should be considered.

There is no doubt that in some cases the relation may work out as given in the paper, and this brings up another qualification which I have in mind. Electrification is a useful tool for certain local conditions. It may be indispensable in Switzerland in St. Gothard heavy traffic, where a 12,000-hp locomotive has been recently put in service, and it may also be useful on some railroads in this country, but this will not apply to all cases.

Second: It is stated on the third page of the paper that "as a result of many tests with accurate recording instruments, the behavior of a number of electric-locomotive types is now well understood." It is a pity that information more detailed than that which follows in the paper, is not given. It is only mentioned that the rigid-frame type noses on high-speed curves (presumably on curves at high speeds), while the articulated type noses on straight track but runs steadily on curves. Again a greater definiteness, with appropriate figures from tests with recording instruments or at least a reference to other publications, would be desirable. There are many types of high-speed rigid-frame steam locomotives of different design, wheel arrangement, and suspension, which are running stably on curved track, and this notwithstanding the fact that the steam locomotive produces disturbing forces which are usually considered as causing nosing. The recorded difference between the two types of electric locomotives may depend to a great extent upon the location of weights, both laterally and longitudinally, which is different, of course, from those in a steam locomotive. A steam-turbine rigid-frame locomotive built years ago in Germany produced considerable vibration on the road and was ultimately taken out of service, although probably not for this reason alone.

The high-speed self-contained Diesel-electric locomotives built, as the author says, similar to passenger cars, have nevertheless shown remarkable riding qualities, probably due to the proper distribution of weights.

While it is true that the reader should be grateful to the author for whatever information he is given, it may not be out of place to remark that the question of riding qualities of locomotives is extremely important and complex and needs a thorough study, with substantiations of general statements and references to sources.

A. I. LIPETZ.[5]

TO THE EDITOR:

The comparative speed-power characteristic curves, shown in Fig. 1 for steam, electric, and Diesel-electric locomotives, while of course purely qualitative, might be modified somewhat to indicate that, on account of the short-time overload characteristics readily available in electric equipment, the horsepower at the lower speeds rises considerably faster in the case of Diesel and electric locomotives than with steam locomotives. This short-time overload characteristic is especially valuable where rapid acceleration is desirable at low speeds, such as in yard switching service and in local passenger service where stops are frequent. This advantage is so fundamental in yard switching, where a major part of the service is performed at low speeds, that a Diesel locomotive may actually accomplish similar work more quickly than a steam locomotive rated at considerably greater continuous maximum horsepower.

SIDNEY WITHINGTON.[6]

TO THE EDITOR:

Mr. Blunt in his interesting discussion, points out that with steam as with electric locomotives the tendency is to build universal types for fast-freight and passenger service. In achieving this result, the electric locomotive has the in-

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[5] Chief Consulting Engineer, American Locomotive Company, Schenectady, N. Y. Non-resident professor, Purdue University, Lafayette, Ind. Fellow A.S.M.E.

[6] New York, New Haven & Hartford Railroad Co., New Haven, Conn. Mem. A.S.M.E.

herent advantage of higher power from an external source when accelerating from slowdowns. His description of methods of design for single-direction steam locomotives is most interesting. Electric-locomotive design is along rather different lines since it is usually necessary to operate equally well in both directions. Modern double-end designs have been brought to the point where they are at least comparable in performance with single-end designs and where tests have shown them to be superior in tracking qualities to some single-end steam locomotives which are considered entirely satisfactory.

The author is in entire agreement with Mr. Blunt upon the advantages of the articulated locomotive for high power and high speed. This type is particularly suited to electric drive and has the additional advantage that by increasing the number of axles the individual-axle load can be reduced.

Mr. Kerr has suggested rating electric locomotives so as to bring out more accurately their actual capacity for service. Some such measure is certainly much better than the conventional continuous rating. The difficulty is that the true rating is really measured by the tonnage which can be hauled and the relative tonnage ratings of different types of locomotive are not the same on different profiles. This subject of rating deserves more study because of its fundamental importance in judging the merits of different kinds of power.

The author is glad to note that Mr. Kerr confirms his belief that there is no real basis for believing that any serious decrease in adhesion occurs with increase in speed.

In answer to Mr. Laird, it may be noted that the high overload capacities of electric locomotives are currently being obtained without serious increase in weight or cost. It is a fortunate fact that electric equipment designed for high starting tractive effort and high speed, contains in itself the capacity for high power at intermediate speeds for a long enough time to be really valuable in practical railroading.

Mr. Laird's remarks on adhesion are also valuable. The fact, according to the author's observations, that electric-locomotive adhesions do not decrease appreciably with speed may be due to the smooth riding and uniform rail loading of properly designed electric motive power.

Mr. Lipetz brings out the different shapes of the characteristic curves of steam and electric locomotives. It may be noted that if two locomotives have the same horsepower at the maximum speed the electric will have more power than the steam at all lower speeds. While increase in power is definitely limited with a reciprocating steam locomotive, there is no practical limit for the electric locomotive.

It is not claimed that the first cost of an electric locomotive is as low as that of a reciprocating steam locomotive of equal rated power, but among the numerous electrifications both in this country and abroad, there are enough which are economically justified to show a considerable field for electrification from purely economical reasons.

In answer to Mr. Lipetz' questions regarding riding qualities, the author might refer to a brief account of certain tests made on the Pennsylvania Railroad.[7] Many more tests have been made by the author and by others with whom he has been associated. The results, which are the property of the railroads concerned, have not been published but are generally available to other railroads intending to use similar equipment. The author can assure Mr. Lipetz that his statements are well substantiated by the many tests of which he has personal knowledge.

Mr. Withington emphasizes the advantage of electric and Diesel-electric power in switching and local passenger service. The author agrees with this and has perhaps not given sufficient space to it in the paper. The almost universal trend to the purchase of Diesel-electric switch engines in recent years shows that the railroads are alive to the desirable characteristics and to the economy of operation of locomotives with electric transmission.

B. S. Cain.[8]

Possibilities for Utilization of Pulverized-Coal Ash

To the Editor:

For several years we have been investigating the possibilities of the use of fly ash as a replacement for Portland cement in concrete. For this reason, I have studied with more than ordinary interest the paper[9] by Thorson and Nelles in a recent issue of Mechanical Engineering.

In our investigations of fly ashes at the University of California, we have found that the variables which principally affect the strength and other properties of Portland-cement fly-ash concretes are (1) the fineness of fly ash, (2) the carbon content of the fly ash, and (3) the percentage of fly ash used as a replacement for Portland cement.

We believe that as a measure of fineness, the percentage retained on the 200-mesh (74-micron opening) sieve is of little value, since the worth of a fly ash as a pozzuolanic material and as a filler between the particles of Portland cement is directly dependent upon its content of particles in the small micron sizes. The specific surface, which is the calculated surface area per gram of material, is a much better index to fineness. As between two fly ashes, the percentage of material retained on the 200-mesh sieve might be the same, yet the specific surface of one might be 50 per cent greater than that of the other, depending upon the relative efficiency of the dust collectors in the two plants where the fly ashes were produced. If each fly ash were suitably low in carbon content, the fly ash of low specific surface, due to lack of fines, might be unsuitable as an ingredient of concrete, contributing little to strength, reducing resistance to the action of weather, and having no effect on permeability; on the other hand, the fly ash of high specific surface would probably contribute substantially to strength, weathering resistance, and impermeability.

The accompanying Fig. 1 illustrates the effect of fineness on strength of concretes. The two fly ashes from different plants were of the same carbon content (1.1 per cent) and of practically the same fineness as measured by either the 200- or 325-mesh sieve. However, the specific surface of the fly ash from plant *A* was nearly one third greater than that from plant *B*. It will be seen that at all ages the concrete containing fly ash *A* is of substantially higher strength than that of concrete containing fly ash *B*. At the age of 360 days, the strength of concrete containing fly ash *A* is 1500 psi higher than that of the concrete using Portland cement alone or that using fly ash *B*.

As a result of our investigations, in which the percentages of fly-ash replacement of cement were 20, 30, and 50, we have come to the conclusion that properly constituted fly ashes are the best of our pozzuolanic materials. For ordinary concrete construction, subject to the action of weather or to drying conditions, it is recommended that the use of fly ash be permitted as a replacement for Portland cement up to 25 per cent, provided the specific surface of the fly ash is not less than 2500 sq cm per g and the loss on ignition (including carbon) does not exceed 7 per cent. For mass concrete not subjected to drying or to frost action, where high strength is not essential, the

[7] "Track Tests of Electric Locomotives," *Railway Age*, vol. 101, 1936, pp. 374 and 412.

[8] Locomotive Division, General Electric Company, Erie, Pa. Mem. A.S.M.E.

[9] "Possibilities for Utilization of Pulverized-Coal Ash," by A. W. Thorson and John S. Nelles, Mechanical Engineering, November, 1938, pp. 845–851.

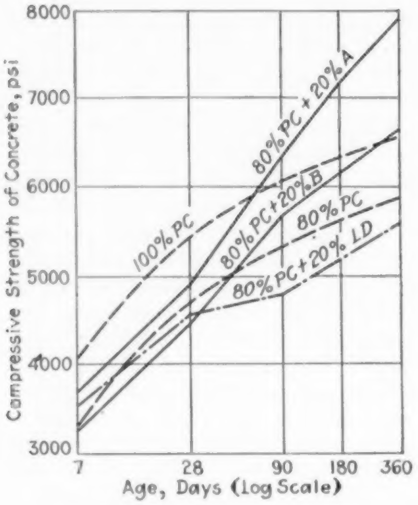

FIG. 1 STRENGTH OF CONCRETES

Curve 100 per cent *PC* shows the strengths of concrete made with Portland cement containing no fly ash.

Other curves show strengths of concrete with 20 per cent of cement replaced respectively by fly ash *A*, fly ash *B*, and limestone dust (an inert material).

Curve 80 per cent *PC* is for concrete having the same amount of cement as those with fly-ash and limestone-dust replacements.

REPLACEMENTS

	Fineness		
	Per cent passing		Specific surface
	200 mesh	325 mesh	sq cm per g
A	95.6	90.5	3220
B	94.9	90.0	2460
LD	95.5	92.3	4240

A, fly ash *A*; *B*, fly ash *B*; *LD*, limestone dust.

use of a fly ash meeting these requirements may be permitted as a replacement of cement up to 50 per cent.

While for a given specific surface, fly ash of higher carbon contents than that limited by 7 per cent ignition loss may not seriously affect the strength of concrete and may not impair its watertightness, if used in replacements as great as 25 per cent it is likely to produce concretes lacking in resistance to frost action and hence may be unsuitable for exposed structures in severe climates. It seems possible that fine fly ashes of fairly high carbon content might be suitable for such structures, provided the replacement does not exceed perhaps 20 per cent; but this is a possibility that has so far not been thoroughly investigated. It also seems possible that higher replacements with such fly ashes might be permitted in structures protected from the weather, such as foundations, subways, and so on.

While Thorson and Nelles do not give the value of the specific surface of the fly ash employed in their experiments, it appears from the sieve analyses given on page 845 that the ash must have been fairly coarse. The statement made on page 849, that "the additions of ash improve the strength of the lean concrete in all cases, but show improvement in the rich concrete only for additions up to 20 per cent" does not appear to be true for fly ashes of higher fineness, as is indicated by the results given in Table 2.

TABLE 2 FLY-ASH CONCRETE

	Fly ash		Compressive strength of concrete at 3 months					
			psi			% of strength for P.C.		
Type	Carbon, per cent	Specific surface sq cm per g	Rich 1.9 bcy	Normal 1.6 bcy	Lean 1.4 bcy	Rich 1.9 bcy	Normal 1.6 bcy	Lean 1.4 bcy
None	..	..	6500	5790	5410	100	100	100
A	1	3220	6770	6230	5550	104	108	103
C	6	3080	7320	6260	5640	113	108	104
D	10	3800	6770	6390	5570	104	110	103

bcy = barrels per cu yd; P.C. = Portland cement.

For these tests each of the fly-ash cements contained 20 per cent of fly ash. All three of the fly ashes would be classed as of fairly high fineness. It is seen that the contribution of fly ash to the compressive strength of concrete was somewhat greater for the rich mix than for the lean mix, though the difference was not large. Also, it will be noted that the fine fly ash, containing 10 per cent of carbon, produced concrete compressive strengths in excess of those produced by the Portland cement alone and exhibited concrete compressive strengths about on a par with those produced by fly ash of lower specific surface containing 1 per cent carbon. This substantiates the statement previously made, i.e., that fly ashes of high fineness and carbon contents in excess of 7 per cent may have no deleterious effect in so far as concrete strength is concerned. However, results of a limited series of tests make it appear that large replacements of fine fly ashes high in carbon are likely to produce concrete lacking in resistance to weather.

In the article of Thorson and Nelles, it is suggested that the fly ash may be dampened for storage. Even a small percentage of moisture will cause fly ash to cake and, although moisture would not in general affect its pozzuolanic activity, from the standpoint of its use as an ingredient of concrete, the ash should be dry enough to be free-flowing, as is Portland cement.

A word of caution is in order. It is possible that certain fly ashes relatively high in CaO may exhibit in concrete excessive delayed expansion. This expansion may be due to hard-burned particles of free lime or to particles of lime-iron compounds, such as dicalcium ferrite. For this reason, a fly ash should be accepted for use in concrete only after a mixture of the fly ash and Portland cement has passed the standard soundness test which is regularly used for Portland cements.

The managements of plants burning powdered coal should realize that fly ash possesses commercial possibilities as an ingredient of concrete. In other words, what has been regarded as a waste product is likely to become a marketable product. In a small way this market has already been developed. If the fly ash from a given plant is to be a marketable product, it must be of reasonably high specific surface, which will require the use of dust collectors sufficiently efficient to prevent the escape of the particles of ash in the small micron sizes.

RAYMOND E. DAVIS.[10]

TO THE EDITOR:

The action of the authors in reporting all experiments even though some were failures is to be approved, for as they have stated, an outlet for fly ash that may be impractical in Detroit may be successful elsewhere.

The Detroit Edison Company has devoted considerable attention to Cottrell block and it is believed that this product will become a distinct contribution to the construction industry. Its qualifications will bear some repetition.

1 Its smooth surface is in contrast to other building units in its own class. The rough texture of other products causes the retention of dust and makes a momentary resting place for rain water. The effect of this can often be seen below window sills as a streaked and soiled appearance of the walls. With Cottrell block a good rain will clean off deposits of dust, and rain water has no resting place.

2 Cottrell block weighs only about two thirds as much as concrete or cinder units, so lighter foundations can be used.

3 As to heat conductivity, when exterior walls are constructed of this material and its hollow cells filled with fly ash, the Federal Housing Commission does not require furring and plastering on the interior surfaces. Incidentally, with this construction an ordinary five-room home will require about twenty tons of ash in the form of blocks and use about five tons of the ash for insulation. By experiment and by experience with actual structures it has been found that no condensation forms on the warm side of the

[10] Professor of Civil Engineering, in charge of Engineering Materials Laboratory, University of California, Berkeley, Calif.

wall nor in the interior of the wall with 0 F outside temperature, 80 F inside temperature, and 35 per cent relative humidity.

4 These blocks can be readily cut with a carborundum saw which makes for neatness, fewer special shapes, and less trouble in laying out partitions when odd lengths are required.

5 Its quality of resistance to fire is of importance, especially in structures in outlying sections.

6 The quality of soundproofness has often been observed. However, this is true of all solid-masonry structures.

7 This material is readily painted and plastered.

As to architecture, this material lends itself to the modernistic form, but it remains for the ingenuity of the architect to develop a pleasing exterior which will typify solid-masonry construction.

Considerable progress has been made in Detroit in obtaining government approval of a large-scale home-building project constructed with Cottrell block. The use of these blocks for exterior walls as well as for partitions, with concrete floors, has been called a new type of construction and as the block itself is a new material these two obstacles had to be overcome. The remaining step is acceptance by the public. It is hoped that during the next year the use of this material will become well established in Detroit.

J. R. JAMES.[11]

TO THE EDITOR:

We are indebted to Mr. James for the contribution of additional information on Cottrell block. As stated in the paper, this material affords one of the most promising outlets for quantity disposal of fly ash.

We were glad to receive the comments of Professor Davis regarding the use of fly ash in concrete, because of his extensive research on this phase of the subject.

The paper was not meant to deal comprehensively with any of the varied possibilities for fly-ash disposal, but to give an outline of each to present to the reader a general picture of the many experiments that were undertaken, together with the measure of success obtained in each case.

There is no doubt that the most valuable portion of the fly ash, when used in concrete, is that which includes the small micron sizes, and since the carbon particles are found in the coarser portion, it is evident that from a physical as well as chemical consideration, the carbon should be kept within reasonable limits as noted in the paper. However, we do not feel that ash not conforming to the limitations set forth by Mr. Davis as to fineness and carbon content should be rejected entirely. His studies have been primarily on ash substitution for cement. There is also a big field for ash admixtures, up to 35 per cent by weight of cement, which unquestionably improve the workability and compressive strength of the concrete. In this connection, we have found that when ash is added to the mix at the mixer, greater mixing time has a beneficial effect on the compressive strength; and this long mixing is economically possible in these days of transit truck mixers.

Since concrete is put to so many uses and is made in such a range of quality, from lean to rich mixes, it is difficult to lay down any definite rules as to the amount of cement that may be replaced safely by fly ash. However, for average mixes of five bags Portland cement per cubic yard of concrete, we believe the substitution should not exceed 20 per cent, as mentioned in the paper. The whole consideration of substitution of fly ash for cement should be tied in with the requirements of the resulting concrete, i.e., where and how it is placed, and what is expected of it as to strength, weather resistance, and the like. In many cases, for the sake of the increased workability, it would be an added advantage to replace 20 per cent of the cement with 35 per cent by weight of fly ash. We believe there is a decided advantage to be gained in this direction, even though the water-cement ratio may be slightly increased.

Mr. Davis' objection to adding moisture to the ash would, I think, be modified if he could see the method used at our Trenton Channel Plant, where the problem was given a great deal of thought. The ash is fed from the storage bunkers to the dampener by gravity, and the flow is regulated by means of a motor-driven adjustable-speed Star feeder. The ash enters the raised end of the dampener through a duct, which passes through a stationary end, sealed against the rotating main drum of the dampener by means of a rubber ring. The rate of feeding is adjusted at the discharge end of this duct, which delivers the ash close to the bottom of the drum. Spray nozzles, located inside and near the top of the revolving drum, furnish the necessary water. The speed of the Star feeder and the quantity of water through the sprays are regulated by the operator and can produce a surprisingly uniform moisture content. A stationary scraper, running the entire length of the drum, and a baffle to retard the discharge of the ash from the drum, assist in a thorough mixing of the ash and water. The ash as it comes from this dampener looks surprisingly like a damp fine sand.

We have used ash dampened in this manner and have found no tendency to ball up in the mixer. The ideal percentage of moisture, in our experience, seems to be approximately 15 per cent.

A. W. THORSON.[12]
JOHN S. NELLES.[13]

Considerations on Rupture Under Triaxial Stress

TO THE EDITOR:

Professor Bridgman presents[14] some interesting speculations on the rupture of materials under conditions of triaxial stress. As he states, materials in practical use are often subject to more complicated states of stress than the simple tensions, compressions, and shears employed in routine testing. Fortunately, however, the most general cases are not common, as illustrated by the difficulty of putting even a small portion of a solid under some of the states of stress conceived to be possible. Professor Bridgman's suggestion that certain special three-dimensional cases may be resolved into a hydrostatic pressure or tension and a one-dimensional stress, together with his hypothesis that the pressure coefficient remains "qualitatively" constant, provides a convenient tool for theorizing.

When laboratory specimens are subjected to a simple compressive load, the resulting state of stress is not simple unless the ends of the specimen are perfectly lubricated. The ultimate fracture in such specimens, if there is any, will be the formation of cracks parallel to the axis of the specimen (an effect similar to the pinching-off effect, and much easier to obtain) or diagonal cracks, indicating shear failure.

When materials are subjected to an extremely great hydrostatic pressure, time becomes important as a variable. The earth's shape indicates that, with respect to forces that are constant with respect to time, it is made of materials that act as liquids. With respect to varying forces, the earth behaves almost as a solid. Deep in the earth's crust, states of stress such as Professor Bridgman pictures must exist. Sudden failures in this region cause earthquakes. It seems more likely

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[12] Engineer, Production Department, The Detroit Edison Company, Detroit, Mich. Jun. A.S.M.E.

[13] Engineer, Construction Department, The Detroit Edison Company, Detroit, Mich.

[14] "Considerations on Rupture Under Triaxial Stress," by P. W. Bridgman, MECHANICAL ENGINEERING, vol. 61, February, 1939, pp. 107–111.

that these are accompanied by shearing fractures than by "simple compressive fractures."

CHESLEY J. POSEY.[15]

Metropolitan Junior Group Objectives

TO THE EDITOR:

The junior group organization of the Metropolitan Section, A.S.M.E., has been the outgrowth of a feeling among the older members of the Society and the young graduate engineers themselves that such a subdivision would be advantageous in exerting influence and inaugurating initiative among the juniors.

The objectives of the juniors can be divided into two classifications, namely, benefits which the members derive through their activity in the junior and senior groups through their contacts, and the benefits realized by others through contact with these active members. By attending general and specialized meetings, as well as seminars organized under the direction of either the juniors or the juniors and seniors cooperatively, the young engineer is able to follow general engineering development and keep up with the times, particularly in his specialized field. By joining in the discussions and meeting with other juniors as well as seniors, he obtains a more thorough knowledge of his particular specialization and thereby further advances himself in engineering practices. Also, by accepting a position on junior committees or as a junior adviser on some senior Metropolitan or national committee, the young engineer gets a more thorough insight into Society activities and becomes more interested in assuming further responsibilities in the Society.

Activity by the junior members in Society matters of this nature proves of great assistance, as the experience gained in both administrative and executive work of the junior group results in a person's being more confident in himself. Through acquaintances made at the various meetings and seminars, the junior members also acquire for themselves ability which will be of value to them at some future time when they hold responsible engineering positions—ability to make friends readily, to speak extemporaneously on many subjects, and to hold another's interest during such a talk or discussion. Of course, in addition, it is the endeavor of the Junior Metropolitan Section to assist in every way so that the members attending the junior meetings may become acquainted with all other juniors at the meeting and thus develop friendships which need not be limited to the scope of the Society.

It is further the object of the junior organization to assist both directly and indirectly all other groups of the Society in any way which may prove beneficial to either their own group or the other subdivision of the Society. The purpose of the junior group is not merely to extend junior functions, but to further Society activities, using as the medium junior fellowship. Assistance by the juniors to other groups in the Society indicates their willingness to aid in carrying out some of the routine functions of the Society, and also their desire, through learning, to assume greater responsibilities in the operation of the organization.

C. K. HOLLAND.[16]

Job for Engineering Societies

TO THE EDITOR:

I feel the engineering societies have one definite job to do, more important than those they are doing along engineering lines, and that is to sell the profession as a profession to the smaller industrial plants and various manufacturers throughout our country. There are thousands of such companies who could use a draftsman or an engineer to their advantage but they are not educated to that fact. If these smaller companies could be educated to the value of having a technical man on their pay roll, they would benefit themselves and also take up a great number of the unemployed draftsmen and engineers now walking the streets. This educational program should be carried on by the engineering societies; this would be of more interest to us ex-members and probably bring us back to the fold.

My experience has been that engineers cannot sell themselves. After having landed a job the next thing is to sell the engineering department to the employer. This is where business English, forceful elocution, and public speaking are necessary. Quick thinking, debating, and convincing oratory are also an asset in putting engineering problems across at board or plant meetings of executives.

It is pathetic to read some of the letters I receive from engineers holding high positions. One letter I received recently filled one whole page. It was all in one paragraph and worse, all in one sentence.

For about six years I worked for a cement company. My predecessor as chief engineer had sold the department to the company but my chief job was to get along with the strong-willed and hard-headed superintendent. My predecessor had not been able to accomplish this.

By months of psychology and diplomacy this was finally accomplished in the following easy method:

For each new job, two rough drafts were made, one in the normal logical way it should be installed, the other in some other way. These would be shown to him and, as he could not read blueprints well, he would pick one or the other.

Regardless of which one he picked, it was drawn up the way I wanted and when he and I went before the general manager for its final O. K., I would be sure to say "This is the way Mr. ——— wants it installed." This was simple. The superintendent was satisfied; it was his idea and he would move heaven and earth to make it work; it was his baby.

My predecessor never consulted the superintendent; he drew up jobs and had them installed. There was an issue made of each little adjustment and over everything that went wrong; no cooperation was received from the operating department. Nothing ever worked properly, because it was the engineering department's baby.

Psychology is most important in handling men. Never do I give an order. I had an assistant who persisted in telling the foremen, "*I* want this done," or "*I* want that done." After I found out I could not break him of this habit, I let him go.

It is much better to say, "Suppose *we* do it this way," or, "Let *us* get this finished by Friday." If "we" or "us" is used instead of "I," the foreman unconsciously gets the thought he is helping to do the planning instead of just carrying out orders.

How many young engineers have asked for $40 per week and have received this answer: "We'll give you $30 to start and raise your salary just as soon as you show us you're worth it."

They get their job at $30 and may get a raise to $32 or $35 in a year or two. Would it not have been better to make some definite arrangement by saying, "I'll come with you at your figure for six months, then, if my work is satisfactory, I'll expect my figure."

The main job before the engineering societies, therefore, is to sell the profession; and the publications should depart from engineering exclusively to include articles on psychology, diplomacy, labor, and business relations, in connection with the engineering profession. (EX-MEMBER)

[15] Assistant Professor of Hydraulics and Structural Engineering, State University of Iowa, Iowa City, Iowa. Jun. A.S.M.E.

[16] Jun. A.S.M.E.; member, Executive and Administrative Committee, Junior Group, Metropolitan Section, A.S.M.E.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Western A.S.M.E. Sections Invite All Members to Participate in 1939 Semi-Annual Meeting, San Francisco, July 10–15

WITH PLANS and program practically completed and the preprinting of papers well under way all that remains to make the 1939 Semi-Annual Meeting of The American Society of Mechanical Engineers a brilliant success is the participation of every member who can do so in the technical sessions, social events, and plant visits that have been arranged.

Under the supervision of the Meetings and Program Committee of the Society, which is responsible for the conduct of all national Society meetings, and with the active assistance of many local committees at San Francisco and the Committee on Professional Divisions the work of planning details has been going on for months.

So eager are the groups on the Pacific Coast to make the 1939 meeting one of the most instructive and enjoyable ever held by the Society, that a special invitation to members in all parts of the country to assemble at San Francisco has been prepared by them. The cordiality of the invitation which follows is evidence of the real desire on the part of A.S.M.E. Western Sections to serve members of the Society throughout the nation and to make their visit to San Francisco in July a worth-while and memorable occasion.

Special Invitation of Pacific Coast Sections

The San Francisco Section of The American Society of Mechanical Engineers—in fact, each of the seven Western Sections—is looking forward with keen, pleasurable anticipation to the Semi-Annual Meeting at San Francisco during the week July 10–15.

Under the efficient chairmanship of Everett M. Breed, president and general manager of the Pelton Water Wheel Company, the General Committee has completed its organization of local executive and subcommittees, and these committees are busily engaged in building up interesting features for the trips and entertainment portions of the program, and in coordinating these features so that every visiting mechanical engineer shall be able to choose his most desired forms of inspiration, exhilaration, recreation, or relaxation.

The Executive Committee is composed of:

Everett M. Breed, chairman.

George L. Sullivan, vice-chairman Executive Committee; chairman Committee of Information and Registration; professor of mechanical engineering, University of Santa Clara.

H. B. Langille, secretary; associate professor of mechanical engineering (emeritus), University of California.

Warren H. McBryde, chairman Reception Committee; engineering consultant and vice-president A.S.M.E.

W. Harry Archer, chairman Banquet Committee; W. Harry Archer and Associates.

V. F. Escourt, chairman Technical Events Committee; efficiency engineer, Pacific Gas & Electric Co.

A. J. Dickie, chairman Publicity Committee; editor *Pacific Marine Review*.

E. C. Floyd, chairman Printing and Signs Committee; Columbia Steel Co.

O. B. Lyman, chairman Hotels Committee; manufacturer's representative.

F. T. Letchfield, chairman Finance Committee; vice-president Wells Fargo Bank and Union Trust Co.

H. J. Smith, chairman Plant Trips Committee; construction engineer, Gas Department, Pacific Gas & Electric Co.

H. L. Terwilliger, chairman Entertainment Committee; district manager, Ingersoll-Rand Co.

Fairmont Hotel is to be headquarters for the meeting. Perched on the eastern crest of famous Nob Hill, this noted hostelry commands sweeping views of San Francisco, of its great bay, of its bridges, and of the beautiful hills beyond.

In the center of this setting of superb natural loveliness, engineers and architects have created Treasure Island and the Golden Gate International Exposition, which appear as heroic achievements by day and as dreams of iridescent rainbow beauty by night.

Nob Hill was formerly the site of the home palaces of Stanford, Crocker, Fair, Mark Hopkins, and other California millionaires whose names are closely linked with the early history of engineering in that state. Its summit is still traversed by three lines of cars driven by cables installed by Halladie himself.

It was then a mecca for engineers who were seeking financial backing, and it is our hope

Californians, Inc.

A GLIMPSE OF DOWNTOWN SAN FRANCISCO

SAN FRANCISCO WATER FRONT
(Oakland Bay Bridge in background with part of Pacific Fleet at anchor.)

that today its lure will be equally potent.

"Nuf sed." Come on out to the Semi-Annual Meeting and see for yourself. And remember when you pack your grip that San Francisco is a naturally air-conditioned city. In July and throughout the summer a fresh northwest trade wind blows over the North Pacific and cools the city and its surroundings very effectively. Ergo, remember that you will need wraps; that there are many fine golf links and tennis courts available; that the Fairmont has a fine swimming pool and that there are both beach and outdoor pool facilities in great abundance; and that the committees can arrange to have you meet up with a few game sea bass or salmon if your inclinations run in that groove.

If any member has any special contact he wishes to make, any information he needs, or any special wish in connection with the Semi-Annual Meeting, he may write the chairman of the appropriate committee (see foregoing names) in care of the Engineers' Club, 206 Sansome Street, San Francisco, and rest assured that his communication will receive prompt and efficient attention.

The latch string of the Golden Gate is out for all mechanical engineers in July, 1939!

A.S.M.E. Semi-Annual Business Meeting, July 10, 1939

THE semi-annual business meeting of The American Society of Mechanical Engineers will be held on Monday, July 10, 1939, in the Red Room of the Fairmont Hotel in San Francisco, Calif., at 4 p.m.

(Signed) C. E. Davies
Secretary, The American Society of Mechanical Engineers

Service to Science, Industry, and Humanity Theme of A.S.M.E. Semi-Annual Meeting

GREATER service to science, industry, and humanity has been chosen as the keynote of the National Semi-Annual Meeting of The American Society of Mechanical Engineers, to be held in San Francisco, July 10–15, according to an announcement by R. F. Gagg, chairman of the Meetings and Program Committee, which has been working for more than a year with the San Francisco Section of the Society in developing the complete program of technical sessions, inspection trips, and entertainment features. In addition to this, the Golden Gate International Exposition has designated Thursday, July 13, as Engineers' Day, the main feature of which will be an address by Herbert Hoover, honorary member of the A.S.M.E., and the only living ex-President of the United States, who will discuss the contributions which engineering has made to human welfare.

Technical Sessions

Fourteen technical sessions, sponsored by the Aeronautic, Fuels, Hydraulic, Heat Transfer, Power, Management, Process Industries, Oil and Gas Power, and Materials Handling Divisions of the A.S.M.E., will feature 28 papers by outstanding engineers in their field, including Dr. Adolphe Meyer, director of the steam-turbine department of Brown, Boveri & Company, Baden, Switzerland, who will describe the latest developments in internal-combustion turbines. Other papers will cover air transportation across the Pacific, methods of burning California fuels, design of impulse turbines, cooling towers, branch-plant management, a new type of orchard heater, flow of water, insulation of pipes in intermittent service, quick freezing of fruits and vegetables, boiler performance with natural-gas firing, and materials-handling methods and equipment. At the Pacific Coast dinner of the Newcomen Society of England, held in connection with the A.S.M.E. Meeting, Dr. William F. Durand, past-president of the A.S.M.E., will present an historical paper on the development of the Pelton water wheel which will be illustrated with lantern slides.

Plant Visits

A list of the many plants and factories to be visited during the Semi-Annual Meeting is not available yet. However, members and guests will be given every opportunity to see the diversified industries for which San Francisco and Oakland are noted, chief of which are meat packing, sugar refining, grinding of coffee and spices, manufacture of machine tools, printing, and publishing. Also of interest are the transpacific air-line terminals, the shops of the various railroads, the ships which dock in San Francisco Bay, the giant water and power projects, and the Golden Gate and San Francisco–Oakland Bay Bridges.

Women's Program

Besides the luncheons and teas which are planned for the wives and daughters of visiting members and guests, the women will be taken on a tour of the city to see the many sights and attractions for which San Francisco is famous. These include the handsome War

Memorial building with its museum and opera, Market Street, civic center, Chinatown, the Latin and artists' quarters, Golden Gate Park, Fishermen's Wharf, bathing beaches, Lincoln Park, Dolores Mission (built in 1776), Cliff House, and the Presidio, an army post. A drive winding up Twin Peaks gives a splendid view of the city and of Oakland, Alameda, Berkeley, and other suburban cities across San Francisco Bay, as well as Treasure Island, site of the World's Fair.

World's Fair

However, the greatest attraction for everybody will be the World's Fair on man-made Treasure Island, which was dredged up in the center of San Francisco Bay by U. S. Army Engineers. By means of many federal and state exhibits, one is shown the work of the engineer on such superprojects as Boulder, Bonneville, and Grand Coulee, and the two greatest bridges in the world, the $35,000,000 Golden Gate Bridge and the $77,000,000 San Francisco–Oakland Bay Bridge, which provides access to the Fair.

More than 200 industrial concerns, many of them leaders in their fields, are exhibitors in their own buildings or in the various exposition buildings. Among these buildings are the Halls of Science; Homes and Gardens; Electricity and Communication; Foods, Beverages, and Agriculture; Air Transportation; Business Progress; the Mineral Empire; and International Exhibits. In several cases, industries have united for a massed display far more comprehensive than any single firm could present. Among these exhibits are Treasure Mountain, a realistic presentation of mining and allied fields; the huge relief map of the eleven Western states sponsoring the Fair, which presents the entire territory, its resources and its improvements on the scale of one inch to the mile; and the imposing "human interest" story of oil.

Social Functions

On Tuesday evening, Jan. 11, the A.S.M.E. Banquet will take place at the Fairmont Hotel. The guest speaker will be F. T. Letchfield, vice-president and consulting engineer, Wells Fargo Bank. Dancing will follow for both young and old. On Thursday, the members will attend the functions of Engineers' Day at the World's Fair on Treasure Island. Mr. Hoover will address the assembled engineers in the morning and will be the guest of honor at a dinner in the evening.

Meeting Headquarters

Official headquarters for the meeting will be in the Fairmont Hotel, where the majority of the technical and social functions will take place. Because of an expected influx of people to San Francisco for the Fair and the attendant demand for rooms, the Hotel Committee has reserved three hundred rooms at the Fairmont and six other hotels. However, reservations by members and guests for these rooms will not be accepted after July 1. Therefore, fill out your reservation card, which is being sent to you, and return it immediately. If your future plans do not permit your going to San Francisco, the reservation may be canceled without obligation.

A.S.M.E. 1939 Semi-Annual Meeting Program

MONDAY, JULY 10

9:30 a.m.

Council Meeting

2:00 p.m.

Council Meeting
Plant Trips

4:00 p.m.

Business Meeting

6:30 p.m. (by invitation)

Newcomen Dinner at Bohemian Club at which Dr. W. F. Durand will deliver an address on "The Pelton Water Wheel"

TUESDAY, JULY 11

9:30 a.m.

Aeronautics

Toward Economic Air-Line Equipment—Discussion of Trends, Development, and Possibilities, by Allen Bonallie

Fuels I

Some Problems in the Burning of Fuel Oil, by A. W. Anderson*

Design and Operation of De Florez Furnaces, by George C. Leslie*

Hydraulic Equipment

Problems Encountered in the Design and Operation of Impulse Turbines, by Ray S. Quick*

Pump Discharge Valves on the Colorado River Aqueduct, by R. M. Peabody*

Power-Heat Transfer

The Performance Characteristics of a Mechanically Induced Draft, Contraflow, Packed, Cooling Tower, by A. L. London, W. E. Mason and L. M. K. Boelter

Fundamental Relationships in the Design of Cooling Towers, by G. Russell Nance*

2:00 p.m.

Management I

Organization Problems of Branch-Plant Management, by Paul L. Davies*

Labor Problems of Branch-Plant Management, by Alex. R. Heron

Fuels II

The Characteristics of Atmospheric Type Burners When Used With Natural Gas, by Everett D. Howe and Harold G. Johnson*

A New-Type Orchard Heater, by A. S. Leonard*

Applied Hydraulics

The Flow of Water in Channels Under Steep Gradients, by W. F. Durand*

Analogy Between Hydrodynamics and Heat Transmissions in Fluids, by Th. von Kármán

6:30 p.m. A.S.M.E. Banquet

Toastmaster: W. F. Durand
Speaker: F. T. Letchfield

WEDNESDAY, JULY 12

9:30 a.m.

Heat Transfer

The Economic Thickness of Insulation for Pipes in Intermittent Service, by R. L. Perry and W. P. Berggren

Actual and Model (Wind Tunnel) Tests on the Rate of Spread of Forest Fires, by John R. Curry and W. L. Fons

Management II

Management in the Small Plant, by Lillian M. Gilbreth*

Agricultural Engineering

Basic Engineering Factors in Agricultural Technology, by L. M. K. Boelter

The Quick Freezing of Fruits and Vegetables by Immersion, by John P. Ferris and R. Brooks Taylor*

Heat Transfer in Revolving-Coil Pasteurizers, by R. L. Perry

Water Regimen of Soils in Place in the Field, by F. J. Veihmeyer

2:00 p.m. Plant Trips

8:00 p.m.

Council Meeting Continued

All members of the A.S.M.E. are invited

THURSDAY, JULY 13

Engineers' Day at Golden Gate International Exposition

Address by Herbert Hoover

FRIDAY, JULY 14

9:30 a.m.

Power

Boiler Performance With Natural-Gas Firing, by F. G. Philo*

Elements Entering Into the Exact Measurement of Natural Gas, by John Overbeck and S. R. Beitler

An Improved System in the Application of Noncondensing or Extraction Turbines, by H. W. Cross and E. S. Wells, Jr.*

Oil and Gas Power

Gas-Turbine Problems, by Adolphe Meyer

Materials Handling

The Economic Considerations of Materials Handling, by Wm. H. Jaenicke

2:00 p.m. Plant Trips

* Papers starred are being preprinted for the meeting and will be mailed to members of the Society upon request as soon as copies are available.

Institution of Mechanical Engineers of Great Britain to Meet With A.S.M.E., Sept. 4–8, 1939

New York World's Fair to Provide Background for Joint Meeting

FOR the first time in thirty-five years, except for a short visit in 1932, The Institution of Mechanical Engineers of Great Britain is coming to the United States this fall, Sept. 4 to 8, to meet with The American Society of Mechanical Engineers. As in 1904, at the time of the St. Louis Exposition, the World's Fair in New York is providing an interesting background for this joint gathering. Our British guests will also visit Boston, Toronto, Detroit, Cincinnati, White Sulphur Springs, Washington, and Philadelphia.

At the time of the New York meeting the two societies of mechanical engineers will be joined by the Institution of Civil Engineers and the Engineering Institute of Canada who are meeting with the American Society of Civil Engineers. Both British groups will come from England on the *Samaria* and arrive on Sept. 3 in Boston where they will be greeted by the Boston Committee. After luncheon and a sight-seeing trip, the party will entrain for New York for arrival in the evening. The mechanical engineers will be housed at the Hotel Pennsylvania, the civil engineers at Columbia University.

The General Program Scheme

The program in New York will start on Labor Day, Monday, Sept. 4, and will continue throughout the week. The events for both mechanical- and civil-engineering groups are being planned jointly and will be included in a single printed program. The general scheme of the mechanical-engineering program in New York is as follows:

On Monday, Sept. 4, after morning sightseeing, both mechanical- and civil-engineering groups are to gather in the afternoon in the Engineering Societies Building for an opening session, followed by a reception and tea. Opportunity will be given to visitors to inspect the Library and the various societies' headquarters offices. In the evening, the group will visit Radio City.

On Tuesday morning, Sept. 5, there will be a session on Marine Transportation in the Engineering Societies Building followed by a boat trip with the civil engineers around the water front of New York City. Luncheon will be served on board. Later in the afternoon the boat will land near the World's Fair where the evening will be spent.

On Wednesday, Sept. 6, following a morning session on Railroad Transportation, there will be a luncheon at the Pennsylvania Hotel, and later a visit to the railroad exhibits at the World's Fair. In the evening there will be a joint banquet at the Waldorf Astoria with speakers representing the three countries participating in the meeting.

On Thursday, Sept. 7, following a morning session on Highway Transportation and luncheon at the Pennsylvania Hotel, the party will visit the motor and highway transportation exhibits at the World's Fair. In the evening, members of the party are invited to join with Columbia University in celebrating the 75th anniversary of the founding of its Engineering School.

On Friday morning, Sept. 8, a session on Transatlantic Airplane Transport will be held at the World's Fair, followed by a general closing session also at the Fair in which all groups of engineers will participate. In the afternoon there will be a visit to the near-by North Beach Airport.

In addition to the visits to the World's Fair, opportunity will be given for visits to selected industries near New York. Golf will also be arranged for any who wish to play.

An attractive program of entertainment and visits is being arranged for the ladies. This will include an all-day motor trip and visits to museums, shops, and the World's Fair.

The Pennsylvania Hotel has been selected as the headquarters hotel. The registration headquarters will be at the Engineering Societies Building where all sessions will be held except those on Friday morning. The civil engineers and their guests will have registration headquarters and hold their sessions at Columbia University.

Technical Program

The technical program, by agreement with The Institution of Mechanical Engineers is to be devoted to the Mechanical Problems of Modern Transportation, a subject of great importance and one in which both countries have made noteworthy contributions. A session is to be devoted each to marine, railroad, highway, and transatlantic-airplane transport. At each session, there is to be one paper by a British and one by an American author as follows:

Marine Transport:

Paper by Sterry B. Freeman, superintending engineer, Alfred Holt & Co., Liverpool, England

Paper by Robert C. Lee, vice-president, Moore & McCormack Co., Inc., New York, N. Y.

Light-Weight High-Speed Trains:

Paper by William A. Stanier, chief mechanical engineer, L.M.&S. Railway, London, England

Paper by Charles T. Ripley, chief engineer, Technical Board, Wrought Steel Wheel Industry, Chicago, Ill.

Highway Transportation:

Paper by E. C. Ottaway, technical officer, London Passenger Transport Board, London, England

Paper by F. C. Horner, assistant to the chairman, General Motors Corp., New York, N. Y.

Transatlantic Airplane:

Paper by A. Gouge of Short Bros., Rochester, England

Paper by Edmund T. Allen, director of aerodynamics and flight research, Boeing Aircraft Co., Seattle, Wash.

As preprints of the papers are expected to be available in July, it is planned that the papers will be presented in brief and the time of the sessions devoted largely to discussion.

The British Tour

On Saturday morning the British visitors will embark for a boat trip up the Hudson River to Poughkeepsie where they will entrain for Niagara Falls.

On Monday, Sept. 11, it is expected that the British civil engineers will meet the mechanical engineers at Niagara Falls for a joint visit to Toronto. There the parties will separate; the civil engineers will visit Ottawa and Montreal before their departure for home; the mechanical engineers will take the train for Detroit where they will spend a day or more visiting automobile and steel plants. In Cincinnati another day or so will be spent in the machine-tool and other industries and then the party will go to White Sulphur Springs.

In Washington on Tuesday and Wednesday, visitors will be shown the beauties of the city and some of the Government buildings. In Philadelphia on Thursday and Friday visits will be made to chosen Philadelphia industries. The party will return to New York on Saturday to board the steamer for home.

Committees

The plans for the meeting are under the general supervision of the Committee on Meetings and Program of which R. F. Gagg is chairman. A General Committee under the chairmanship of George L. Bourne is being organized. It will be made up of past-presidents and honorary members of the Society and members in the United States of The Institution of Mechanical Engineers. The New York Executive Committee, under the chairmanship of John Castlereagh Parker, includes Mrs. George W. Farny, Thomas B. Allardice, Joseph W. Barker, Stephen F. Voorhees, and John P. Hogan.

Officers of the local sections in the cities to be visited are cooperating wholeheartedly in the plans for a cordial welcome to our British visitors. The Boston Committee has appointed Irving Moultrop as chairman. Other section appointments are now being made.

Engineers and Inventors Asked to Assist A.E.C. Patent Inquiry

ASSISTANCE of engineers and inventors is being sought by the American Engineering Council in an inquiry of the patent system of the United States that is now under way. The Council has prepared a questionnaire for the purpose of uncovering information and statistical data. The following statement and the accompanying questionnaire are published at the request of the Council in an effort to give wide publicity to the inquiry and to assist in rounding up the information desired.

Patent System Vital to Engineers

Engineers have a vital professional interest in the operation of the American patent system. It is through the privileges created by the Constitutional provision permitting patent grants that technological development, through which many engineers derive their principal basis of livelihood, has been fostered. Thus it is that the American Engineering Council, as the representative of the engineering profession at large, has been looked to as an impartial agency to carry forward a joint inquiry into the whole patent situation, in conjunction with the National Association of Manufacturers and The National Industrial Conference Board.

Reasons for Patent Inquiry

The patent and the system through which it is created has been primarily regarded as an essential medium to facilitate the translation of invention into products or services. Though there is less cause to question the basis upon which the patent itself is founded, a realignment of factors caused by the increasing complexity of business and the severity of competition has given cause to question many of the ways in which the patent privilege has been put to use.

It is of primary importance, accordingly, to ascertain whether patents have had their intended usefulness to the engineer as an inventor. Has he been able to successfully put to use his inventions and derive a satisfactory benefit from them? Does the patent provide him with a positive and effective means to assert his claims against others who have devised similar technical improvements? What channels have been made available to him through the patent to convey title to his invention to those who can make best use of it, and what obstacles has he encountered? Engineers, therefore, can make a significant contribution through this Inquiry.

Prompt Attention Requested

To obtain a broad and representative cross section of the experience of engineers at large with the patent system and the use of their patents, the questionnaire reproduced in these pages is being brought to their attention through the cooperation of their professional societies. A true picture of the engineer's relation to our patent system can only be set forth through the whole-hearted response to this questionnaire by those who still have an interest in unexpired patents, or even those who have in the last 17 to 20 years made application for a patent, regardless of the fact that they may consider their own experience as nothing unusual or unique. To make this picture available to the contributors, a summary of the findings will appear in a later issue. It shall be understood, of course, that all statements or other information given in reply to the questionnaire will be treated as strictly confidential by those conducting the inquiry.

The questionnaire appearing in this issue has been designed for convenience in making reply, and readers are urged to send their answers promptly to the American Engineering Council, 744 Jackson Place, Washington, D. C.

Joint Patent Inquiry

National Association of Manufacturers, The Conference Board, American Engineering Council

QUESTIONNAIRE TO ENGINEERS AND INVENTORS

In the interests of promoting the engineer's relation to invention, will you kindly indicate your experience in connection with your own inventions and the use of your patents, by answering the following questions:

Your reply will be held *strictly confidential.*

1 What Patents Have Been Issued to You Since 1921?

Please list official Patent Numbers:

.... [ ] .... [ ] .... [ ]

.... [ ] .... [ ] .... [ ]

.... [ ] .... [ ] .... [ ]

(*Continue on separate sheet, if necessary*)

2 Check (×) in Boxes Provided in Question 1 Those Patents Which Have Been and/or Now Are in Commercial or Practical Use. (As defined in Question 3.)

3 How Have You Put These Patents to Use? (See Question 2.)

Enter total number of patents applicable to each item:

(*a*) In your own business [ ]

(*b*) By assignment to others [ ]

(*c*) By outright sale [ ]

(*d*) By license to others [ ]

(*e*) Placed in pools [ ]

(*f*) Dedicated to public [ ]

(*g*) Other uses (Describe)

.... [ ]

.... [ ]

4 What Are the Principal Reasons for the Nonuse of Your Patents Not Checked in Question 1?

Enter total number of patents against each item which indicates the principal reason for their nonuse:

(*a*) No adequate market demand for your invention................ [ ]

(*b*) Invention competitively at a disadvantage.................... [ ]

(*c*) Foreign competition........... [ ]

(*d*) Awaiting commercial development........................ [ ]

(*e*) Awaiting completion of further technical development........ [ ]

(*h*) Lack of financial backing....... [ ]

(*i*) No ready purchaser for patent.. [ ]

(*j*) Neglect........................ [ ]

(*k*) Other reasons for nonuse (state)

.... [ ]

.... [ ]

(*Questionnaire continued on following page*)

(*f*) Invention brought out ahead of opportunity for use.......... [ ] .... [ ]

(*g*) Invention has detrimental potentialities..................... [ ] .... [ ]

5 Have You Encountered Any Premeditated Opposition From Others to the Working or Use of Your Patents for Reasons Other Than Those Listed in Question 4?

State total number of patents thus willfully suppressed [ ]

6 How Many of Your Patents Listed in Question 1 Have Been Involved in Litigation?

(*a*) State total number of patents reaching court trial: [ ]

(*b*) State the total number of individual court trials in which your patents have been involved (sum of District, Appellate, Supreme Court trials): [ ]

7 Indicate the Nature of Conflict Which Has Thus Involved These Patents in Litigation. (See Question 6.)

Enter total number of patents against each item which indicates the cause of conflict:

(*a*) Infringement.................. [ ]
(*b*) Invalidity..................... [ ]
(*c*) Valid but no infringement...... [ ]
(*d*) Similarity of your claims to those in patents in other technical fields........................ [ ]
(*e*) Conflict with "nuisance" patents [ ]
(*f*) Other causes of conflict....... [ ]
.... [ ]
.... [ ]

8 State the Number of Patents the Validity of Which Has Been Sustained in Litigation [ ].

9 Have Any of Your Patent Applications Been Denied on Questions of:

Please check (X)

(*a*) Utility, novelty, or creativeness [ ]
(*b*) Procedural requirements........ [ ]
(*c*) Priority (interferences)......... [ ]
(*d*) .... [ ]
(other)

10 What Rewards or Satisfactions (Other Than Monetary) Have Come to You Through Your Patented Inventions?

Please state in what form such benefits have been received:

....

....

....

(If you have any comments or suggestions based on your own experience with the patent system, please include them on a separate sheet).

11 What Are Your Professional Connections?

Field of engineering experience..

Principal Society affiliation...

Name..

Mail address..

Signature...

Your replies to the above questions will be appreciated, and should be mailed to:

Joint Patent Inquiry,
AMERICAN ENGINEERING COUNCIL,
744 Jackson Place,
Washington, D. C.

FREDERICK M. FEIKER
Executive Secretary

FAIRFIELD E. RAYMOND
Director of Patent Inquiry

W. H. Boehm Honored at Dinner by Boiler Code Committee Members

WM. H BOEHM

WILLIAM H. BOEHM, engineer, educator, and executive, after 28 years of active service on the Boiler Code Committee of The American Society of Mechanical Engineers, retired on April 28, 1939, at which time his colleagues on the Committee honored him with a dinner at the Engineers' Club, New York. Dr. D. S. Jacobus, chairman of the Committee, presided.

In travesty of the regular proceedings of the Boiler Code Committee, the occasion took the form of a "special session," at which reports of special committees were read by Henry B. Oatley, Charles E. Gorton, and Dean Arthur M. Greene, Jr. According to these reports, Mr. Boehm was the last remaining active member of the first seven members of the Committee appointed on Sept. 15, 1911, by Col. E. D. Meier, during his term as president of the Society.

Since that time the Code has been changed from an incomplete document into one which has served the public and the profession so well in promoting safety, continuity of service, and unrestricted sale of pressure vessels, that it has been incorporated into the laws of 24 states, 18 cities, the Panama Canal, and the Hawaiian Islands.

In his capacity as executive of one of the leading insurance companies in the country, Mr. Boehm originated "flywheel insurance," out of which grew engine and turbogenerator insurance. This was followed by his development of power-machinery insurance which has been adopted by all casualty insurance companies.

In his response to the reports, Mr. Boehm praised the efforts and work of Dr. Jacobus and the rest of the members, and then concluded by saying, "I deeply appreciate the action you have taken in making me an honorary member of the Committee and thank you for giving this splendid dinner in my honor."

A.S.M.E. Represented at the University of New Mexico Celebration

J. R. VAN DYKE, associate professor in engineering, Eastern New Mexico Junior College, Portales, New Mexico, was appointed by President A. G. Christie as honorary vice-president to represent The American Society of Mechanical Engineers at the fiftieth anniversary celebration of the founding of the University of New Mexico, June 4–5, in Albuquerque, N. M.

A.S.M.E. Council Reports on Recommendations of 1938 Group Delegates Conference

NATIONAL delegates of the seven regional conferences of the local sections of The American Society of Mechanical Engineers met in New York during the 1938 Annual Meeting of the Society and formulated recommendations which were presented informally at the Council meeting of Dec. 9, 1938. These recommendations were presented in writing to the Secretary of the Society on Jan. 30, 1939, and transmitted to the committees concerned and to members of the Council on Feb. 6, 1939.

At its meeting in New Orleans, Feb. 23 and 24, 1939, the Council devoted more than three hours' time to consideration of the recommendations. The Executive Committee of the Council gave further attention to them on March 17 and April 21. A report, which summarizes all actions taken to date, has been prepared, appears as an appendix to the April 21 minutes of the Executive Committee of the A.S.M.E. Council and has been mailed to all local sections.

The National Conference asked that the recommendations and Council action on them be published in the June issue of Mechanical Engineering, and to this suggestion the Council assented with the provision that the published material be limited to recommendations requiring action, and that it appear in briefed form. What follows, therefore, has been briefed from the complete report, copies of which may be obtained from the Secretary on request.

Local Sections Finances

Action on two recommendations relating to increased appropriations for local-section activities was conditioned by lack of funds in sight for the coming fiscal year, and it appears that appropriations recommended by the Finance Committee for the 1939–1940 budget in respect to these items will be about the same as they were in 1938–1939. One of these recommendations strongly urged an increase in appropriations to the Committee on Local Sections so that work done by the sections could be restored to full strength and effectiveness. The other recommendation asked for provision of travel allowances to local-sections delegates based on actual reasonable expenses.

Administration of Local Sections

Several recommendations relating to the administration of local sections were referred to the Committee on Local Sections. Summarizing actions on these recommendations it is reported that:

(1) An annual letter from the Secretary to the local sections should suggest self-analysis of section operations.

(2) When a local section desires the affiliation of a member who resides within its territory or in territory not assigned to or more conveniently served by another section, it may request headquarters to ask the member for his preference in the matter or it may extend the invitation of the section to him.

(3) Recommendation will be made to all local sections that their officers assume office July 1; that election of local-sections officers be held at least three months prior to the time they assume office; and that names of elected officers be forwarded promptly to headquarters so that the "Manual for Local Section Operation" may be sent to these officers prior to their assumption of their offices.

(4) Visits by national officers to local sections' meetings are to be continued, within the limits of the budget and the convenience of the officers in question.

(5) It is suggested that each section establish a legislative committee and that suggestions for its activities be included in the "Manual for Local Section Operation."

(6) The Council expressed its view that election of local-section officers by letter ballot is desirable, unless conditions lead a local-section executive committee to decide otherwise.

(7) It was the opinion of the Council that intimate cooperation between local sections and professional divisions is desirable.

(8) The Council concurred in the desirability of intimate cooperation between national and local societies.

(9) The recommendation to revise the By-Laws so as to legalize designations "regional conference" and "regional delegates," and "national conference" and "national delegate" in references to the annual group conferences of local-sections delegates and the group delegates conference, respectively, and this action was referred to the Committee on Constitution and By-Laws.

(10) The Committee on Local Sections plans to appoint some junior members to prepare a page on "Junior Operation" for the "Manual of Local Section Operation."

(11) The same committee recommends that local sections send all program material to student branches for posting, and that all program announcements of local sections carry an invitation to student-branch members to attend its meetings.

Society Organization

On matters relating to national Society organization the Council noted that the Finance Committee plans to continue to publish annually in Mechanical Engineering a chart showing income and expense per member. It also authorized the distribution to the chairman and secretary of each local section a copy of the complete annual income and expense statement of the Finance Committee, with schedules of investments and trust funds, as now provided to members of the Council. It considered carefully the subject of unification of the engineering societies and came to the conclusion that such action is not desirable at this time. In respect to policy of charging a registration fee for nonmembers attending national meetings of the Society, the Council voted to approve the recommendation that such a fee be changed and that mechanism to waive the fee in certain cases be established. The recommendation was referred to the Committee on Meetings and Program.

Membership List

A suggestion that the "Membership List" be published every two years was referred, with strong recommendation that it be adopted, to the Committee on Publications. (An appropriation to cover issuance of the "Membership List" is being considered in preparing the 1939–1940 budget.)

Employment Service

The Council decided that it is not feasible to send Employment Bulletins to local sections as this is a service restricted to those who pay for it. It also reported that negotiations are now under way for the establishment in Detroit of a branch employment office.

Society Development

A number of recommendations dealt with the major question of Society development. In this connection it is important to note that the Council, on December 5, 1938, approved in principle the recommendation of the Committee on Local Sections that efforts be made to increase the number in the member grade by the formation of a national committee made up of past chairmen, or suitable mature members, of each local section. On Dec. 9, 1938, the newly organized Council for 1939 authorized the initiation of a National Committee on Society Development and to date about fifty local sections have designated nominees who have been officially appointed by the President to serve on the committee.

The Committee on Local Sections has been requested to take the responsibility for the preparation of the budget for the National Committee on Society Development and to take the leadership in laying out a program for carrying out the tasks assigned to the National Committee on Society Development by the Council, upon recommendation of the local-sections delegates.

The Council suggested that one of the duties of members of the National Committee on Society Development be that of interesting industrial officials and engineers conducting important work in their territory in the work of the A.S.M.E. and the opportunities for service to the profession.

The Council expressed the view that the pamphlet on "Aims and Activities" be revised when the present supply is exhausted and in accord with whatever budget provision is made, all in accord with the program to be developed by the National Committee on Society Development.

Noting that funds are not available for a portable publication display, the Council recommended that this item be considered in the budget for Society Development for 1939–1940.

The Council expressed the view that data relative to work done or sponsored by the A.S.M.E. in research, standardization, codes, publications, professional divisions, meetings, and the library should be included in the revision of the pamphlet on "Aims and Activities," and that a functional organization chart of the Society be included also.

It was noted that the library can provide microfilm copies of papers at $1.50 for 33 pages.

FIRST ANNUAL SPRING ROUND-UP OF A.S.M.E. METROPOLITAN SECTION AT THE HOTEL ASTOR, NEW YORK CITY, APRIL 20

"Spring Round-Up" of Metropolitan Section Features Technical Sessions and Dinner

750 Hear Talks on Present and Future Engineering Developments by President A. G. Christie and Others

THE METROPOLITAN SECTION of the A.S.M.E. was host to about 750 members and guests at its first annual "Spring Round-Up," held at the Hotel Astor, New York City, on Thursday, April 20, 1939. Starting at 2 o'clock in the afternoon, a series of technical sessions featured papers on the past and future developments in various fields of mechanical engineering by such outstanding speakers as Igor Sikorsky, E. G. Bailey, A. T. Larned, John Haydock, R. M. Gates, L. K. Sillcox, O. F. Allen, and M. C. Horine. Preceding dinner in the grand ballroom of the Hotel Astor, a get-together meeting in the cocktail lounge afforded an opportunity to meet old acquaintances and to make new ones. During dinner, entertainment was furnished by a twelve-piece orchestra, talented singers, soprano and baritone. Then the guest of honor of the evening, Prof. A. G. Christie, President of the A.S.M.E., addressed the audience on the subject of "An Engineering Way Out." Following his talk, Joseph Dunninger, master mind of modern mystery, mystified incredulous engineers with feats of magic, card tricks, and mind reading for almost two hours.

J. M. Driscoll Greets Meeting

The afternoon sessions were opened by John M. Driscoll, chairman of the Section, who greeted the members and guests. "On behalf of the executive committee of the Metropolitan Section" he said, "I take great pleasure in welcoming to this event members of the A.S.M.E. and their guests. This is the first time when Section members with varied interests are brought together at one place in order to show the unity of our organization. Therefore, the committee has arranged this one-day program with afternoon technical sessions featuring top-notch men in the profession and a social evening, including a fine dinner and entertainment."

Aeronautics and National Defense

Mr. Driscoll then turned the meeting over to P. E. Frank, engineer with Sinclair Refining Co., and chairman of the technical sessions, who introduced the first speaker, Igor Sikorsky, chief engineer, Sikorsky Aircraft Co. Speaking on "Aeronautics and National Defense," Mr. Sikorsky described to an interested audience the things he observed on his recent visits to German, British, and Italian aircraft-manufacturing plants. In discussing the possibilities of the United States being attacked from the air, he said, "With respect to the danger of an air attack, this country has probably the best and safest geographic location as compared to any other country in the world. However, the great industrial sections that must be protected and the necessity to maintain the proper standing in line with the importance of this nation, in my mind, fully justify the steps which have been taken by our government to protect ourselves."

The next speaker, E. G. Bailey, vice-president, Babcock & Wilcox Co., reviewed the latest developments in fuels and power. Talking about fuels, he said that "while coal, oil, and gas are the fuels most commonly used, there is an increase in the use of wood refuse, bark, waste liquor from pulp mills, tar, and miscellaneous fuels. These are being burned more extensively and more efficiently." After discussing trends in furnace, boiler, power-plant equipment, and turbine design, he concluded, "While changes and improvements will continue, as they have in the past, the immediate future will likely be recorded in history as a period of consolidation of the good points and advantages from recent experiences, toward more reliable operation with less stress laid on low cost of equipment or high thermal efficiency and more on dollar efficiency and sound economics."

Hydraulics

Then followed a paper on hydraulics, presented by A. T. Larned, civil engineer, Phoenix Engineering Company. "In order to reduce the cost per kilowatt of installed capacity," Mr. Larned said, "the trend is toward fewer units of as large a size as possible consistent with the load requirements and the physical limitations of the station. In many cases only a single large unit is installed and provisions made for the later installation of additional units as the load increases."

Machine Shop Practice

"Despite the fact that the United States possesses a machine-tool manufacturing industry that is superior to any available to a foreign power, we are definitely trailing Germany in the modernization program of our machine shops which is so essential to military preparedness and national defense," declared the next speaker, John Haydock, man-

aging editor, *American Machinist*. After comparing German and American progress, Mr. Haydock stated that recent improvements in the United States have been achieved through (1) the use of multiple operations in one machine-tool setup; (2) the use of machines where the workpiece moves from station to station, having certain operations performed on it at each stopping point; (3) the wider application of broaching; (4) improvements in automatic machinery; and (5) increased application of abrasives to improve surface quality of crankshaft bearings and other machine parts.

Management

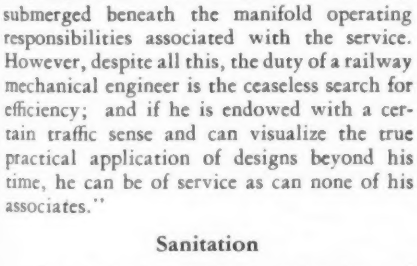
Management was the subject of Robert M. Gates, vice-president, Combustion Engineering Company. According to Mr. Gates, the efficient operation of industry is possible if it is realized that (1) management must establish the integrity of the enterprise, confidence in its aims and personnel, and service to the community; (2) the proper selection and training of young engineers is of vital importance; (3) it is the duty of both engineers and management to meet the increasing demands in the development and perfection of more and better goods at as low a price as possible; (4) cooperation toward a mutual understanding of each other's problems is essential; and (5) engineers and management have a common objective in striving to assure a continuing and profitable return on the investment in men and money.

Railroads

In his talk on the railroad phase of mechanical engineering, L. K. Sillcox, first vice-president, The New York Air Brake Company, stated, "Shop equipment of railroads, more frequently than not, is sadly outmoded. The details of maintenance costs are often submerged beneath the manifold operating responsibilities associated with the service. However, despite all this, the duty of a railway mechanical engineer is the ceaseless search for efficiency; and if he is endowed with a certain traffic sense and can visualize the true practical application of designs beyond his time, he can be of service as can none of his associates."

Sanitation

After reviewing sanitary engineering and its various phases from Roman times to the present day, Lieut.-Col. O. F. Allen, retired, U. S. Army Reserve, said, "It appears that there is a fascinating field for the most intelligent efforts of mechanical engineers to provide the mechanisms which will help the civil engineers to greatly reduce the cost of sanitation services to our communities. The share of the mechanical engineers seems to be rapidly increasing in the developments in those branches of sanitary engineering concerned with the disposal of wastes and the purification of our streams, lakes, beaches, and harbors."



PRESIDENT CHRISTIE ADDRESSES THE DINNER MEETING OF THE METROPOLITAN SECTION

Road Transportation

Talking about motor-vehicle transportation on the highways, Merrill C. Horine, engineer, Mack-International Motor Truck Corporation, discussed recent developments in this field. However, according to him, the most far-reaching and basic engineering developments in the motor-vehicle field are found in the motorbus industry. Not only did the motorbus pioneer rear-engine location, but was also the first to embody unit, chassis and body-frame construction whereby the enormously potent section modulus of the body is employed as the principal truss for the vehicle structure. Remote control of the power plant has been developed to a state of perfection in modern motorbuses at a time when passenger cars are only just commencing to grope uncertainly in that direction, declared Mr. Horine.

An Engineering Way Out

In his address, President Christie, recalled that we are in the tenth year of the depression and that there is no apparent way out offered by economists and politicians. Reviewing the ten-year period, he pointed out that it was one of rapid change. Changes had been made in social and industrial organization to meet real and imagined emergencies. Crises had succeeded crises, he said, and emergency cases had developed troubles of unexpected nature in other services and industries. Yet with it all, he said, "we still are splashing around in the Sea of Depression, making little headway toward the Land of Prosperity. . . . We fret and fume over changes that have occurred; we bemoan the necessity of conforming to new requirements; yet what we need is more change."

When we talk of a high standard of living in the United States, President Christie said, what we really mean is that we can fill more of our wants than others and that we have still other wants to fill. The supplying of these wants forms the basis of our industrial life, and calls for factories, workers, managers, engineers, and research men. New materials, new machines, new services, new employment, and new methods are needed. The problem of the engineer, he contended, is to inaugurate the changes necessary to set up the productive machinery to satisfy these wants.

As examples of new devices and products to fill men's wants, he suggested the following: New safety devices and better engines for aircraft; more reliable instruments; lighter-weight and lower-cost automobiles; simpler and less expensive air-conditioning equipment; noncombustible substitutes for wood in house construction; strong metals for use up to 1200 F; industrial uses for that abundant element, silicon; lower-cost power production, possibly by fuel cells; more economical steam, and Diesel locomotives; smokeless fuels; and devices for cleaning chimney gases.

AT THE METROPOLITAN SECTION DINNER
(The one he caught was this long!)

Engineers had done much to develop methods of economical production, he said, and yet one must feel that our government has little conception of true management and does not care to learn. To support this view he cited the apparent attitude of government toward labor-capital relations, control of industry, wages and hours, "bonused" cotton, and price fixing. The nation can only regain its former market or create new ones, President Christie asserted, when efficiency in production is coupled with high wages. Extended markets from low production costs would do much to stop employment. And finally, he said, there exists the problem of high distribution costs, the lowering of which would increase consumption and employment.

"I am an optimist on the future of America," he said in closing. "The South has only started to produce. Only a few mines have scratched the surface of the pre-Cambrian shield, that 'golden horseshoe' extending around Hudson's Bay. We are not through growing. We still have unfilled wants. Here, then, is our engineering chance. Let us introduce the changes that permit fulfillment of wants; develop new inventions, new services, and new methods; change the relations of labor and capital to secure cooperation; vociferously expose fallacies of government mismanagement of business; deliver goods to customers at lower costs and absorb the unemployed through the resulting demands on industry. This, gentlemen, constitutes 'An Engineering Way Out.' "

Following a tremendous and prolonged applause, J. Schuyler Casey, president, M. H. Treadwell Company, and the toastmaster, thanked President Christie for his enlightening address. Mr. Casey then introduced Joseph Dunninger, world-famous magician, who, it is rumored, will entertain the King and Queen of England on their visit to Washington.

Success Due to Committee

The success of the "Spring Round-Up" affair was mainly due to the hard work and efforts of the arrangements committee, headed by Charles A. Hescheles and consisting of Frank D. Carvin, William H. Larkin, E. J. Billings, T. B. Allardice, H. C. R. Carlson, Arthur E. Blirer, A. R. Mumford, C. K. Holland, H. G. Oliver, Jr., W. McC. McKee, T. Baumeister, Jr., A. Ehbrecht, E. H. Fezandie, P. W. Keppler, S. H. Libby, William Raisch, O. B. Schier, II, W. A. Shoudy, H. W. Walter, F. R. Warner, Roy V. Wright, and others.

News of Local Sections

Connecticut Sections Hold Annual Outing, May 18

CONNECTICUT SECTIONS of the A.S.M.E. banded together to run the eighth annual outing of the Group, which was held this year under the auspices of the Bridgeport Section at the Mill River Country Club, Stratford, Conn., on May 18. The Committee composed of T. H. Beard, chairman, and A. H. Beede, secretary, both from the Bridgeport Section; F. W. Keator, New Haven; C. C. Stevens, New Britain; E. S. Denison, Norwich; Wm. K. Simpson, Waterbury; and G. R. Truedsson, Hartford, attempted to strike a balance between entertainment, recreation, and some business so that the program would appeal to members, wives, and guests. The program included golf in the morning and afternoon, luncheon at the club, plant visits in the afternoon to the Stanley Works, Underwood-Elliott-Fisher Co., and Warner Bros. Co., a business meeting addressed by President A. G. Christie and Assistant Secretary Ernest Hartford of the National Society, and a dinner in honor of President Christie, who spoke on "Engineering Acquaintances."

Atlanta Has Papers on Arc Welding and Dust Collection

Atlanta Section at its luncheon meeting on April 3 presented Robert Daniels, who gave an illustrated lecture on arc welding, showing its uses as a maintenance tool, for hard surfacing, and repairing industrial machinery. At its evening meeting on April 7, Herman Van Tongeren, Dutch engineer and expert on dust and smoke control in municipal areas, discussed in detail the fly-ash and smoke problems common to most cities, illustrating his talk with motion pictures. He told of the methods used in European cities in coping with the problem, explaining ordinances governing the nuisance and the equipment used to reduce contamination of air.

Monel and Rolled Nickel Discussed at Akron-Canton

H. L. LaQue, director of technical research of the International Nickel Co., New York, addressed the Akron-Canton Section at its meeting on March 31. "The Fundamental Characteristics of Monel and Rolled Nickel" was the subject of his paper, which was illustrated with slides and films. James Forrest, chairman of the Section, presided.

Anthracite-Lehigh Valley Hears About Hydraulic Machine Tools

From uses in gun recoiling mechanisms in 1880, presses in 1900, machine tools in 1920, hydraulic mechanisms have made rapid strides to date, according to C. C. Stevens, executive engineer, New Departure Division, General Motors Corp., in a paper presented at a meeting of the Anthracite-Lehigh Valley Section in Easton, Pa., April 28. Essential elements were explained, and slides were used to demonstrate some unusual modern applications.

125 Members and Students at Baltimore Section Meeting

The development of refrigeration to its present stage was discussed by John M. Lambert, York Ice Machinery Corporation, on April 19 at a meeting of the Baltimore Section attended by 85 members and 40 student members from Johns Hopkins University and the University of Maryland. The Baltimore Junior Group played host to student members prior to the meeting. Mr. Lambert also gave a comparison of ammonia, freon, and carbon dioxide as refrigerants, as well as revealing some startling applications of mechanical refrigeration to industries not thought of by the layman.

PROF. A. G. CHRISTIE, PRESIDENT OF THE A.S.M.E., GIVEN HONORARY MEMBERSHIP IN PI TAU SIGMA AT DINNER PRECEDING TALK BEFORE ANTHRACITE-LEHIGH VALLEY SECTION AND LEHIGH STUDENT BRANCH, IN BETHLEHEM, APRIL 19

(Sitting, left to right: Prof. Paul B. Eaton, Lafayette College; Dr. C. C. Williams, President of Lehigh University; Courtland Carrier, President of Lehigh Student Branch; Prof. A. G. Christie, President A.S.M.E., Johns Hopkins; Stuart N. Lewis, Corresponding Secretary of Lehigh Chapter. Standing: F. C. Peters, Chairman of Anthracite-Lehigh Valley Section; Alan Grant, Treasurer of Lehigh Student Branch; Associate Professor J. R. Connelly, Prof. F. V. Larkin, and Associate Professor B. H. Jennings, all of Lehigh University; L. G. Sprague, President of Lehigh Valley Engineers Club.)

Television Meeting in Bridgeport Draws 500

More than 500 members and guests attended the "television" meeting of the Bridgeport Section on April 11 to hear Donald Pugsley, General Electric Co. of Bridgeport, describe the latest advances made in England, France, Germany, Holland, and the United States. Various commercial units were demonstrated by Mr. Pugsley.

Central Pennsylvania Has J. C. Hunsaker for Speaker

At a joint meeting with Sigma Xi at The Pennsylvania State College on April 20, members of Central Pennsylvania Section learned about "Recent Developments in Aeronautics" from Commander Jerome C. Hunsaker, head of the department of mechanical engineering at M.I.T., and member A.S.M.E.

Chicago Sponsors Religious Service to Honor Engineers

The Chicago Section was one of the sponsors of a service in honor of engineers held on Sunday, May 7, at the First Unitarian Church. In recognition of the work of engineering and its values to the whole community, the congregation and the minister recited the psalm of labor, part of which reads as follows:

So was he that fortified the city
And brought water into the midst of them;
He digged the sheer rock with iron,
And builded up wells for water.
They shall not labor in vain,
For their labor is with wisdom and with knowledge and with skillfulness.
All these put their trust in their hands;
And each becometh wise in his own work
Without these shall not a city be inhabited,
And men shall not sojourn nor walk up and down therein.
For these maintain the fabric of the world;
And in the handiwork of their craft is their prayer.

200 Attend Out-State Meeting of Detroit Section in Midland

More than 200 members, guests, and their wives gathered in Midland on April 28 for the annual "out-state" meeting, and to engage in a program climaxed by a lecture by Donald Gibbs on "Wonders of the Synthetic World." The program consisted of a tour of the Dow Chemical Company, a dinner in the Dow cafeteria, words of welcome from Dr. John J. Grebe, director of physical research for the Dow Company, and from L. J. Richards, chief engineer, and the paper by Mr. Gibbs. In attendance were members from Midland, Bay City, Saginaw, East Lansing, Lansing, Milford, Grand Rapids, Jackson, Detroit, Alpena, Holland, and Benton Harbor.

Junior Members in Hartford Arrange Meeting on Research

At a meeting arranged by the Junior members of the Hartford Section on April 14, Dr. H. R. Moulton, American Optical Company, talked on "Research—Its Importance and Functions in Industry." Such questions as the advisability of establishing research departments, return on investment, cooperation with other concerns, methods of procedure, type of personnel, were answered by Dr. Moulton.

"G-Man" Is Guest Speaker at Los Angeles Section Meeting

R. B. Hood, special agent in charge of the Los Angeles division, Federal Bureau of Investigation, was the guest speaker at the April 19 meeting of the Los Angeles Section. Mr. Hood's paper, entitled "Science and Engineering in Crime Prevention," described the large part which engineering plays in his work. The other speaker of the evening, Paul Shoup, president, Southern Californians, Inc., talked on "Industrial Relations and the Engineer."

Feedwater Regulators Is Meeting Topic in Louisville

Steam-flow-type feedwater regulators were described by Don Allshouse, at the April 19 meeting of the Louisville Section, held in the Speed Scientific School. According to Mr. Allshouse, many modern steam generators are confronted with very wide load swings which powdered-fuel equipment meets successfully. Expansion and contraction of water in the boiler plus load demands give rise to violent fluctuations in water level which cannot be controlled properly by a single-element regulator. Steps in the design and performance curves of a regulator capable of holding the water at constant level were shown.

Milwaukee Hears Originators of Helium-Oxygen Mixtures

On April 27, members and guests of Milwaukee Section heard an interesting talk on deep diving and the use of helium-oxygen mixtures for divers and for pressure workers, given by Dr. Edgar End, of the department of physiology of the Marquette University School of Medicine. Present also was Dr. End's associate in developing helium-oxygen mixtures, Joseph Fischer, who is chief engineer of Milwaukee County institutions. Mr. Fischer supplemented Dr. End's remarks.

Nebraska Members Assist in "Golden Spike" Celebration

To celebrate the world premier of the motion picture, "Union Pacific," Omaha designated April 26–29 as "Golden Spike Days." Members of the Nebraska Section did their part by having a special meeting on April 28 when the Union Pacific R.R. gave members an opportunity to inspect the new 5000-hp steam-turbine locomotive and to hear a description of it by one of the raiload's engineers. Also shown was an 1869 locomotive.

JUNIOR GROUP OF A.S.M.E. BOSTON SECTION AT DINNER PRECEDING MEETING ON APRIL 5

(Candid-camera shot by Roger Matter, a member of the Boston Section Junior Group. It is the first meeting of the Section in many years that the women have been invited to attend. The dinner and the meeting were most successful.)

Minnesota Members Inspect Sewage-Disposal Plant

After hearing a talk by George J. Schroeder, chief engineer of the Minneapolis-St. Paul Sanitary District sewers and sewage-treatment plant, members of the Minnesota Section were conducted through the extensive plant on their inspection trip there on April 26.

Ladies' Night at Ontario Draws More Than 100

Annual ladies' night of the Ontario Section was held on April 14 at the Savarin Hotel in Toronto. There were present more than 100 members and their wives. The speaker of the evening, Col. Frank Chappell, had as his topic, "Modern Developments in Materials." His illustrations suggested some of the materials likely to become of practical use in the not-so-distant future and outlined the part modern research is taking in their development.

Process Industries Meeting Held in Philadelphia

On April 25, at a meeting of the Philadelphia Section attended by 60 members and 30 guests, mainly from the Philadelphia Chemical Society, R. T. Van Ness, E. I. DuPont de Nemours & Co., described mechanical-engineering activities in the process industries. The paper was discussed by J. M. Brentlinger, manager of the industrial-engineering department of the DuPont company, as well as representatives from the Process Industries Division of the Society and the attending chemists.

Pittsburgh Holds Smoke Abatement Meeting

Herman van Tongeren, Dutch engineer and expert on dust and fly-ash control, talked to the Pittsburgh Section, April 4, on dust nuisances and their control. The 104 members and guests learned about the design of centrifugal type of dust collectors and the development of a formula to assist in formulating smoke and dust ordinances. Mr. van Tongeren supplemented his talk with motion pictures.

Raleigh Members Hear Talk by A.S.M.E. Editor

Meeting at North Carolina State College on March 27, members and guests of the Raleigh Section heard a talk by George A. Stetson, editor of the Society, who reviewed the publications of the A.S.M.E., explaining the purpose and scope of MECHANICAL ENGINEERING, A.S.M.E. Transactions, etc., and how papers to be published are obtained and selected. The speaker also covered the biographies, pamphlets, hand books, Mechanical Catalog, and other publications of the Society.

Annual Ladies' Night at Rock River Valley Section

Rock River Valley Section held its annual ladies' night meeting on May 12 in Rockford, Ill. Following dinner, members, guests, and wives, listened to an interesting talk on "Utah-Arizona National Parks," by Dr. R. A. Kirkpatrick, lecturer, author, traveler, naturalist, and educator. At the June meeting, the Section officers will present to the members a proposition to have a mechanical engineer appointed to the Wisconsin Licensing Board, which is now composed of civil engineers.

Mechanical Mining Explained to St. Louis Members

G. Stuart Jenkins, general superintendent, Consolidated Coal Company, spoke to the members of St. Louis Section at a meeting held on April 21, on the subject of mechanical mining. The talk was illustrated with motion pictures and slides.

San Francisco Section Has 15 Past Chairmen at Dinner

Preceding the meeting of the San Francisco Section on March 30, at which Prof. Carl J. Vogt gave a paper on "Magnetically Actuated

Diesel Spray Valves," more than 100 members and guests attended a dinner in honor of the past-chairmen of the Section. At the special table presided over by H. B. Langille '34, there were seated Robert Sibley '13 and '23, C. R. Weymouth '14, B. F. Raber '17, Dr. W. F. Durand '19, W. H. McBryde '25, A. J. Dickie '26, Dennistoun Wood '27, Ross Mahon '29, E. G. Sheibley '30, R. S. Danforth '31, W. M. Moody '32, Sam R. Dows '33, F. W. Collins '35, and G. L. Sullivan '37.

Roller Bearings Discussed at South Texas Section Meeting

The monthly meeting of the South Texas Section, held on April 25, featured S. M. Weckstein, chief engineer of the industrial division, Timken Roller Bearing Co., who spoke on "The Design and Application of Tapered Roller Bearings."

78 at Susquehanna Meeting Hear Dean R. L. Sackett

Meeting in York, Pa., 78 members and guests of Susquehanna Section heard a paper by Dean R. L. Sackett, past vice-president of the Society, on the subject of selection of students for admission to college. According to Dean Sackett, the first point of importance is to find the proper channel for the student during his college career. Of great help to engineers are the cooperative courses which not only educate the student in the problems of industry but help him find his field of specialization.

Editor's Note to All Local Sections' Officers and Members

This issue of MECHANICAL ENGINEERING marks the end of another fiscal year for Local Sections and for this section of A.S.M.E. News. Because very few Section meetings are held during the summer, if any at all, the publication of this section will be suspended until the September, 1939, issue of MECHANICAL ENGINEERING, copy for which must be in on or before August 10, 1939. The editor and his staff wish to thank the officers of all Local Sections, especially the secretaries, for their cooperation in sending in meeting reports and photographs for use in this section.

Members of Toledo Section Visit Acme Power Station

The new high-pressure, high-temperature boiler of the Toledo Edison Co., at the Acme Power Station, which generates steam at 825 psi and 825 F, and the topping unit recently put into service to balance power production was inspected by more than 60 members and guests of the Toledo Section on March 23. A description of the new units was presented before the tour at a meeting in the station by the operating engineer, who also answered the many questions of the visitors.

Washington, D. C., Section Has Sewage Disposal Session

At the meeting on April 13 of the Washington, D. C., Section, Ellwood Johnson gave a clear and detailed description of the manner in which sewage is handled in the District of Columbia. Also described was the operation of the new sewage treatment plant, located on the Potomac River across from Alexandria, Va., and its use of sewer gas for fuel in a gas engine which drives a 1000-kw generator. There was an attendance of 100 members and guests.

Junior Group Activities

Los Angeles Juniors Hear Papers on Oil-Well Tools and Management

MEETING at the University of Southern California on April 3, the Los Angeles Junior Group heard two excellent papers. Ralph Jones, of Byron-Jackson Co., outlined the various tools for oil wells made by his company and showed how the different manufacturers' contours on tubing and sucker rods must be considered in the construction of oil wells. Thomas B. Wilde, of Sutorbilt, presented a talk based on a large chart showing a typical small plant organization plan. Following this paper was a lively discussion on both papers.

Professional Groups Present Papers Before Detroit Juniors

FIRST speaker on March 28 at a meeting of the Detroit Junior Group was C. Williams, who read a paper on "The Big Telescope," which was prepared by the manufacturing group, composed of B. Lane, chairman, M. Toothaker, L. C. Webb, Roy Voorhees, C. Williams, and F. A. Jennings. The paper described the many unique engineering problems which were met and solved in the construction of the 200-inch telescope in California. W. Gilbreth then presented a paper prepared by the heating and ventilating group, which consists of R. M. Neldon, E. P. Decenzo, J. P. Schecter, and Mr. Gilbreth. Entitled "The Heating and Ventilating of Ocean Liners," the paper pointed out how the *Queen Mary* and the *Manhattan* differ in this respect.

CENTRAL-INDIANA SECTION AND PURDUE STUDENT BRANCH MEMBERS HAVE JOINT DINNER MEETING ON MARCH 29 AT THE UNIVERSITY

(Sitting in the center, facing front, is Dean A. A. Potter, past-president of the A.S.M.E.)

Philadelphia Juniors Have Turbine Session and Visit

THE Engineers Club was the scene on April 12 of one of the most interesting meetings held by the Philadelphia Junior Group. Arthur Moody, of De Laval, gave a paper on the "Vibration of Turbine Disks." William Pegram, of Westinghouse, described "Extraction Turbines." On April 22, members of the Group made a trip through the plant of the Baldwin Locomotive Works at Eddystone, Pa.

Juniors of Kansas City Meet

THE regular meeting of the Junior Group of the Kansas City Section was held on Tuesday, April 11, in the K.C.P.&L. Co. Building. E. M. Bruzelius spoke on "Petroleum Refining," in which he explained the general molecular structure of hydrocarbons generally used as fuel and outlined the several methods of distillation of petroleum. Glen Brauninger discussed "The Determination of Relative Humidity of Natural Gas," in which he described a new apparatus devised at M.I.T. to determine the wet bulb or dew point of gas under various conditions. The guest speaker was E. Wegner, whose subject was "Colored Photographic Printing Processes." He exhibited a colored print and explained the procedure necessary to obtain natural colored prints.

Bridgeport Junior Group Visits Steel Point

AN INSPECTION trip was made on April 22, by members of the Bridgeport Junior Group to the United Illuminating Company's Power Plant at Steel Point. Not only were the various stages of high-pressure and high-temperature steam power development explained in detail by Mr. Stearns, the guide, but also many engineering "tricks" were revealed

by him. One of these was the process of forming a concrete tunnel in quicksand which was aided by incoming and outgoing tides to combat man's ingenuity.

Univ. of California Students Meet San Francisco Junior Group

ON APRIL 13 the San Francisco Junior Group held a joint meeting with the University of California Student Branch, in the Engineering building on the University campus. The students under the Chairman, Richard F. Puck, held a regular business meeting, particularly on matters dealing with their coming election of officers for the ensuing year. The seminar chairman, M. Hughes, was then introduced, and he in turn presented the first speaker, R. E. Denzler, of the Union Oil Co.

Mr. Denzler covered the processes in the manufacture of Triton motor oil. By the help of large diagrams he showed the flow of the oil through the refinery and explained the functions of the various pieces of apparatus. He also had samples of the different substances which are extracted at various points in the set-up, which were handed around for examination by the audience. C. J. Gibbs of the Standard Oil Co. was the second speaker. He discussed the various maintenance problems met in an oil refinery. He divided the subject into three parts: pumps, furnaces and stills, and heat exchangers.

Lively discussion followed the presentation of each subject, after which the entire group of eighty Juniors, students, and visitors adjourned for refreshments served in the steam laboratory near by.

Tri-Cities Juniors Have Patent Session and Inspection Trip

THE meeting on March 29 was called to order by vice-chairman, William Blaser, at the People's Power Auditorium in Moline. Fifteen members were present. Vincent Blecker discussed the idea of members of the Group holding discussions on various subjects as a means of developing themselves in gathering and presenting material of interest to the Group. This would probably take the place of some of the inspection trips.

William Blaser introduced the speaker, Bruno C. Lechler of the American Machine & Metals, Inc., of East Moline, Illinois, who brought out that upon patents rest practically all our large businesses. An inventor was given legal protection for his ideas by means of patents which brought into existence the U. S. Patent Office. Mr. Lechler had a number of early issues of patents which he circulated and had each member make certain comparisons. He also pointed out some of the essentials of patents. One patent from the filing date till the day of issue was only 14 days, while another which had 975 claims was over 19 years in getting through the patent office.

A group of eighteen met at the intercepting sewer and sewerage treatment plant in Davenport, Iowa, on April 12 for an inspection trip. The members made a very interesting and enlightening trip through this new plant. The trip ended at 10:15 p.m.

Business and Government Theme of Economics Conference

THE Ninth Annual Economics Conference at Johnsonburg, N. J., on the general theme of "Business and Government" is being sponsored by Stevens Institute of Technology, the Management Division of The American Society of Mechanical Engineers, and the New York Section of the American Institute of Mining and Metallurgical Engineers. The Conference this year begins on Saturday evening, June 24, and continues through Monday morning, July 3.

There is an offering of courses each hour of the morning on the subjects of our patent system, industrial psychology, job evaluation and merit rating, labor and wages, taxation of business, and cost analysis and control. The evening schedule provides for the following addresses by leading businessmen and economists: "Business and Government—An Orientation View," by Dr. L. S. Lyon, Brookings Institution; "Can Business and Government Cooperate to Produce Full Employment?" by Dr. Mordecai Ezekiel, U. S. Department of Agriculture; "Enterprise Vs. Authority as Principles of Economic and Social Progress," by Virgil Jordan, president, National Industrial Conference Board; "A Program for Railroad Recovery," by Judge R. V. Fletcher, Association of American Railroads; "Government and the Business of Transportation," by Carroll Miller, Commissioner, I.C.C.; "Tasks Ahead for the N.L.R.B.," by Elinore M. Herrick, N.L.R.B.; "The Current Approach to the Monopoly Problem," by Thurlow M. Gordon; "The National Labor Relations Act and Its Administration," by John C. Gall; and "Recent Monetary Policies," by Prof. Walter E. Spahr, N.Y.U. Full Information about the Conference may be obtained by writing to President Harvey N. Davis, Stevens Institute of Technology, Hoboken, N. J.

Fuels Division Plans Joint Meeting With A.I.M.E. in Columbus, O., Oct. 5–7

PLANS are now being made for a joint meeting of the Fuels Division of the A.S.M.E. and the Coal Division of the A.I.M.E. The meeting is to be held in Columbus, Ohio, Oct. 5–7, with technical sessions on the 5th and 6th, and industrial plant visits the morning of the 7th. A dinner on the evening of the 7th and a football game at The Ohio State University on the afternoon of the 5th are scheduled.

Precedent for a well-supported and successful meeting lies in similar joint meetings held in Chicago in 1938, and in Pittsburgh in 1937. The general committee for this year's session consists of R. A. Sherman, chairman, J. E. Tobey, H. O. Croft, H. F. Hebley, and H. E. Nold. S. R. Beitler heads the local committee on arrangements, with A. H. Dierker, C. E. MacQuigg, R. F. Stillwell, and W. A. Welcker, Jr., as members.

A.S.M.E. Calendar

of Coming Meetings

July 10–15, 1939
Semi-Annual Meeting
San Francisco, Calif.

September 4–8, 1939
Fall Meeting
New York, N. Y.

October 5–7, 1939
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Columbus, Ohio

October 5, 1939
Machine Shop Practice Division to hold "A.S.M.E. Day" at Machine Tool Congress, Cleveland, Ohio

October 12–13, 1939
Wood Industries Division
Boston, Mass.

November 2–4, 1939
Joint Meeting with American Institute of Physics in a Symposium on Temperature Measurement, New York, N. Y.

December 4–8, 1939
Annual Meeting
New York, N. Y.-Philadelphia, Pa.

Professional Divisions Hold Conference, May 19

A CONFERENCE of representatives of the 17 Professional Divisions of the A.S.M.E. was held at Society Headquarters in New York on May 19. After introductory remarks by L. K. Sillcox, chairman, Committee on Professional Divisions, those present discussed the enforcement of the limitation of sessions at national meetings, methods of selecting members for executive committees of the Divisions, cooperation of Divisions with Local Sections, ways of obtaining better papers, and the necessity of having exhibits at national meetings of Divisions. Following this discussion, the conference divided into four departments to discuss programs for the four national meetings to be held in 1940.

Alfred Iddles to Represent A.S.M.E. at N.D.H.A. Meeting

DURING the week of June 26, the National District Heating Association is holding its annual convention at the Hotel Pennsylvania in New York City. The A.S.M.E. will be represented by Vice-President Alfred Iddles, who has been invited to make an address at one of the sessions, which starts on Tuesday and ends on Friday. A program of the convention may be obtained by writing to association headquarters, 1317 Spruce Street, Philadelphia, Pa.

ATTENDING THE LANGLEY FIELD CONFERENCE

N.A.C.A. Stages Aircraft Conference at Langley Field

BECAUSE of the international situation, greater secrecy than usual prevailed at the aircraft conference staged by the National Advisory Committee for Aeronautics at Langley Field, May 2. In spite of this handicap, Alexander Klemin, chairman, A.S.M.E. Aeronautic Division, and professor of aeronautical engineering, Daniel Guggenheim School of Aeronautics, New York University, who represented MECHANICAL ENGINEERING, was able to prepare a report on such features of the conference as can be made public. Professor Klemin's report follows:

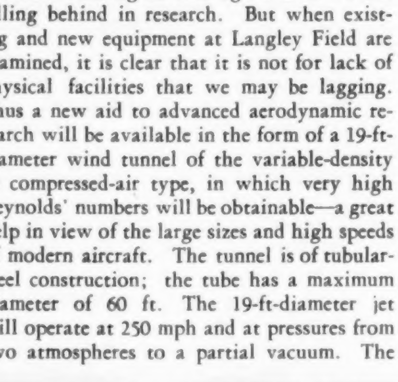
Conference Held in Atmosphere of Secrecy

Dictatorships abroad cause many things at home. Even though we are not at war, the National Advisory Committee for Aeronautics, which does much confidential work for the Army and Navy, pledged editors and reporters visiting Langley Field to secrecy. Information issued to visitors dealt with many interesting matters, but in very guarded fashion.

This was particularly true in the matter of a new airfoil form in which skin friction has been greatly reduced. The boundary layer on the leading portion of an airfoil is laminar inflow; at a certain distance from the leading edge, a transition point occurs and the boundary-layer flow changes to a turbulent flow. The causes of this transition are still a matter of some mystery, but it is definitely known that the skin friction of turbulent flow is many times greater than the skin friction of laminar flow. Since skin friction is now so large a proportion of the modern "clean" airplane, a really important increase in efficiency would follow were it possible to retard the transition point, or rather to displace it to a point near the rear. This is precisely what has been achieved in a new airfoil form, in which laminar flow has been maintained almost up to the trailing edge. But not a hint was given of the character of the airfoil form. Even intelligent discussion of the possible airfoil would no doubt be severely punished.

New Wind Tunnels Attract Attention

With similar restrictions on other information issued at the field, the present note must deal solely with the development of new apparatus. In newspaper reports dealing with the research survey of Colonel Lindbergh, it has been said again and again that we are falling behind in research. But when existing and new equipment at Langley Field are examined, it is clear that it is not for lack of physical facilities that we may be lagging. Thus a new aid to advanced aerodynamic research will be available in the form of a 19-ft-diameter wind tunnel of the variable-density or compressed-air type, in which very high Reynolds' numbers will be obtainable—a great help in view of the large sizes and high speeds of modern aircraft. The tunnel is of tubular-steel construction; the tube has a maximum diameter of 60 ft. The 19-ft-diameter jet will operate at 250 mph and at pressures from two atmospheres to a partial vacuum. The aerodynamic engineers operating the tunnel will become "sand hogs," since they will have to work under the pressure conditions of the jet, with special air locks and a decompression chamber to help them. Air-cooling apparatus and dehumidifiers are also brought into play to give reasonable working conditions. The complete tunnel is 271 ft long and 128 ft wide, and the 34.5-ft propeller is driven by an 8000-hp electric motor.



FREE-FLIGHT WIND TUNNEL AT LANGLEY FIELD

Visiting engineers were highly pleased with the new variable-density tunnel, but it cannot be said that they were equally impressed with the so-called "free-flight wind tunnel." A venturi-type tunnel is mounted on a steel framework; it has a test section diameter of 12 ft and is about 30 ft long. The whole apparatus is mounted on bearings so that the tunnel can be tilted through a wide range of angles. Tilting the tunnel means tilting the air stream, and a light model gliding down the air stream remains stationary in space. Five wires lead to electromagnets in the fuselage of the model airplane so that control surfaces can be actuated by the pilot outside the tunnel. Therefore it should be possible to "fly" the model and make studies of control and stability under conditions simulating full flight. The actual impression, however, was that the apparatus partook somewhat of the character of a scientific toy.

Researches on N.A.C.A. Cowling Under Way

As airplane speeds become higher, the problem of airplane drag becomes complicated by the "compressibility burble," the formation of shock waves at speeds approaching the speed of sound. With the usual N.A.C.A. cowling, for example, an airplane speed of 325 mph causes local flow speeds exceeding 710 mph. The cowling has excellent form at 250 mph, but a very poor one at 400 mph. The researches at very high speeds now being conducted are therefore of the highest importance to modern aviation.

Among other interesting information gleaned, can be mentioned satisfactory tests of a "safety fuel" which does not give off inflammable vapors at temperatures lower than 105 F, and thus reduces fire hazard. Safety fuel used in an engine equipped with a fuel-injection system gives the same power output and

low fuel consumption as a gasoline engine. The possibilities of safety fuel will be at once appreciated

Decentralization Urged

There is one criticism of Langley Field which is current—the extreme centralization of research. Such centralization makes for uniformity of thought which is undesirable, and for vulnerability in time of war. The N.A.C.A. itself is aware of these dangers; hence its proposal for another station at Sunnyvale, Calif., and the allocation of problems to Universities engaged in aeronautical work, where personnel is in many instances of a higher caliber than at Langley Field itself.

National Defense Group Takes Interest Poll

UNDER the capable leadership of chairman W. S. Patterson, the National Defense Group of the Metropolitan Section of the A.S.M.E. conducted a poll of interest of the 250 who attended the Group's meeting on March 8. In order of interest, the general topics were current events, mobilization, organization, training, and tactics and technique. Greatest interest in current events was concerned with international and South American topics. Under mobilization, industrial preparedness drew the most votes.

Members Asked to Express Opinion on Economic Reviews

FOR a number of years, the department of economics of M.I.T., under the sponsorship of the Management Division, A.S.M.E., has provided extended reviews of current books on economics for use in MECHANICAL ENGINEERING. The executive committee of the Management Division would be interested to have the personal and frank opinions of A.S.M.E. members about these reviews and whether they should be continued. Letters should be addressed to the chairman of the Division, W. H. Kushnick, Anchor Cap and Closure Corp., 22 Queens Street, Long Island City, N. Y.

S.A.E. World Automotive Congress Invites A.S.M.E.

EXECUTIVE COMMITTEE of the A.S.M.E. Council has accepted an invitation from the Society of Automotive Engineers for members of the Society to participate in the World Automotive Congress, which starts on May 22 in New York and, after stops and meetings in Indianapolis, Detroit, and Chicago, concludes in San Francisco on June 8.

The 16-day program of the Congress opens in New York, May 22–28, with five days of technical sessions. Two additional days will be spent in visiting the World's Fair and other points of interest in and about the city. From New York the delegates will proceed to Indianapolis where they will view the Indianapolis Memorial Day race on May 30, after having inspected the racing cars and pits the previous day. The Congress will then travel to Detroit for three days (May 31–June 2) of inspection trips to automobile factories and a technical session. At San Francisco (June 6–8) the Congress will hold technical sessions and make visits to San Francisco's Golden Gate World's Fair. All members of the A.S.M.E. are invited to take part in the Congress.

The opening session of the Congress in New York, May 22, features an address on "World Events and the Engineer," by James D. Mooney, member A.S.M.E., and vice-president, General Motors Corp. Other topics to be covered include fuels, lubricants, various types of motor vehicles, transportation, maintenance, aircraft, and internal-combustion engines.

New England Engineers Extend Invitation

AN INVITATION to all engineers visiting the New York World's Fair to include New England in their itinerary has just been issued by The Engineering Societies of New England, Inc., 715 Tremont Temple, Boston, Mass. Information may also be obtained by those interested upon application at the All-New England information booth at the Fair.

Open house throughout New England to engineer guests will afford them numerous opportunities to inspect items of interest in civil, mechanical, electrical, chemical, and general engineering work, as well as the educational institutions.

British Foundrymen Award Fox Medal to H. A. Schwartz

UPON nomination by Sir H. C. H. Carpenter and Sir William Larke, the E. J. Fox Medal of the Institute of British Foundrymen is to be awarded in June to H. A. Schwartz, member A.S.M.E., manager of research of the National Malleable and Steel Castings Company, and professorial lecturer in metallurgy at Case School of Applied Science, Cleveland, O., "for his contribution to the manufacture of malleable castings." This is the first time the medal has been awarded to anyone outside Britain. The first recipient was Prof. Thomas Turner.

Woman's Auxiliary to A.S.M.E. Adds to Its Student Loan Fund

AT THE April board meeting of the Woman's Auxiliary to the A.S.M.E., held at the Engineering Woman's Club, Mrs. George W. Farny presiding, the treasurer, Mrs. A. H. Morgan, reported $491.39 in the general fund and $2153.70 in the educational loan fund.

On April 13 at the Engineering Woman's Club, the first yearly benefit for the student loan fund was held. A representative of the International Silk Guild gave a demonstration talk, "Can you tell Silk, Wool, Linen, Cotton, and Rayon when you see them?" preparatory to a contest in which the winning member received sufficient silk for a dress. Mrs. Harvey Fletcher was the winner. A short business meeting preceded the demonstration. The entire proceeds were turned over to the educational loan fund.

Reports of Sections

Mrs. Albert Kingsbury reported that following the BALTIMORE SECTION luncheon meeting early in February, the members went to Walter's Art Gallery to view a private collection. The section has also had several home bridge parties. The proceeds from these parties will be added to the student loan fund. Mrs. Vincent M. Frost reported that the CLEVELAND SECTION voted in February to assist a student at the Case School of Applied Science. The March meeting featured a luncheon and inspection trip to the Jane Adams School, a vocational school for girls. A men's night with A.S.M.E. members as guests, was planned for April.

Mrs. G. Laurence Knight reported that PHILADELPHIA continues to hold enthusiastic meetings. The bridge party for the Educational Loan Fund resulted in raising $94.50. Early in May Mrs. Hopping gave a travel talk.

Applications for Student Loans

All applications for student loans must be made on Auxiliary forms and accompanied by required endorsements, it was announced. Applications must reach the Educational Committee ten days before regular meetings of the Auxiliary, which are held on second Thursdays of each month, from September to June. Application blanks with complete instructions will be sent on request by the chairman of the committee, Mrs. Roy V. Wright, 398 North Walnut St., East Orange, N. J. A letter received from a recipient of a student loan reads: "Words cannot express my gratitude toward such a fine organization as yours. Recently I was promoted to the position of chief engineer of my company, and only through the financial aid given me by the Woman's Auxiliary to The American Society of Mechanical Engineers can I attribute my success." Another recipient wrote: "Your consideration has made it possible for me to receive my degree in June."

Mrs. Farny reported on her trip to California during which she sowed the seed of local sections in Salt Lake City, San Francisco, and Los Angeles. She is especially optimistic about the prospects in Salt Lake City and Los Angeles. Requests have been received from Toledo, Ohio, Charlotte, N. C., and Atlanta, Ga., for more information on purposes and methods of organizing.

As the fiscal year ends October 1, all members entering May 1 or after may be exempt from payment of dues until the first of October of the succeeding fiscal year.

The regular May meeting was held on May 11 at the Engineering Societies Building for the purpose of discussing the resolution passed by the executive board recommending the formation of a METROPOLITAN SECTION.—BURTIE HAAR, Chairman, Publicity Committee.

American Engineering Council

Presents

The News From Washington and Elsewhere

Federal Public-Works Agencies Combined by Presidential Order

EXERCISING the authority granted him under the new reorganization act, President Roosevelt on April 25 submitted to Congress the first of three plans for regrouping the functions of various agencies of the federal government. The plan will become effective in 60 days unless disapproved, as a whole, by a majority vote of both the Senate and the House of Representatives within that period, or unless Congress in the meantime adjourns. Since the House on May 3 voted down a resolution of disapproval, only an early adjournment could prevent its taking effect on June 24.

The plan brings to practical fruition the long campaign, actively promoted by American Engineering Council, for the establishment of a federal department of public works. While the terms of the reorganization act prohibit the setting up of a new cabinet department, as originally projected by American Engineering Council, the Federal Works Agency proposed by the President will be its substantial equivalent. To it are transferred the functions and personnel of "those agencies of the federal government dealing with public works not incidental to the normal work of other departments, and which administer federal grants or loans to state and local governments, or other agencies, for the purpose of construction."

Present Departments to Be Regrouped

Transferred to the new Federal Works Agency will be the Bureau of Public Roads, now in the Department of Agriculture, the Public Buildings Branch of the Procurement Division, Treasury Department (which designs and supervises construction of federal buildings in all parts of the country); the Branch of Building Management of the National Parks Service, Department of Interior (which selects sites for and determines the order of construction of public buildings in the District of Columbia); the United States Housing Authority, now in the Department of the Interior (slum-clearance); the Public Works Administration; and the Works Progress Administration (both independent agencies set up on a temporary basis). Still unchanged is the present supervision of the Corps of Engineers over river and harbor improvements and flood-control works, since this agency was specifically exempted by the reorganization act.

Heading the new agency will be a Federal Works Administrator, to be appointed by the President with the advice and consent of the Senate, at a salary of $12,000 per year, and an Assistant Federal Works Administrator at $9000. The present heads of the units transferred to the agency will, in general, be retained, and will report to the administrator. Any personnel in excess of the needs of the new agency will be transferred to other government posts or given a preferred status on such eligible lists as are available for future employment.

Security and Loan Agencies Set Up

The general plan for reorganization, as set forth in the President's message, envisions two additional new agencies to be known as the Federal Security Agency and the Federal Loan Agency. The present major independent agencies of the government (except those exempted by law) will be attached either to one of these three, to one of the ten existing executive departments, or, in a few instances, to the White House executive office.

Assigned to the new Federal Security Agency will be those existing bureaus and divisions of which the major purpose is to promote social and economic security, educational opportunity, and health, including the Social Security Board, now independent; the United States Employment Service from the Department of Labor; the Department of the Interior's Office of Education; the Public Health Service of the Treasury; the National Youth Administration, now part of WPA; and the Civilian Conservation Corps.

In the Federal Loan Agency will be concentrated several hitherto independent loan agencies set up to stimulate and stabilize financial, commercial, and industrial enterprises: Reconstruction Finance Corporation; Electric Home and Farm Authority; Federal Home Loan Bank Board; Federal Housing Administration; Export-Import Bank.

Closer control by the chief executive of the three functions of management—budget, planning, and personnel—is provided for by the transfer to the executive office of the Bureau of the Budget, now in the Treasury Department; the National Resources Committee, now a temporary independent agency; and the Federal Employment Stabilization Board from the Department of Commerce. Because of an exemption in the reorganization act a transfer to this office of the Civil Service Commission was impossible, but the President's message stated that one of his six new assistants will serve as a liaison man on personnel problems.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 34, desires teaching, research, testing position. Experience: teaching thermodynamics, hydraulics, mechanical laboratory, drawing 3 years; operating pumping machinery, drafting, hydraulic research, power-plant testing. Me-290.

MECHANICAL ENGINEER, 34; 9 years' experience internal-combustion engine design and drafting, Diesel and aircraft engines. Also research work in design problems and heavy-machine design. Seeks position as engine designer. Me-291.

MECHANICAL ENGINEER, 34; Diesel-engine vibration specialist, 10 years' experience, charge vibration control with prominent engine manufacturer. Licensed N. Y. State professional engineer. Desires new field, preferably similar line as consultant. Me-292.

MECHANICAL ENGINEER; thorough practical factory training; 2 years machine-tool design; $4^1/_2$ years Diesel-engine design; 3 years airplane design; 6 years special aircraft equipment, design, experimental and research work. Me-293.

MECHANICAL-ENGINEERING STUDENT, graduating in June, 1939, desires work in automotive field, or training course leading toward employment in this field. Me-294.

[1] All men listed hold some form of A.S.M.E. membership.

MECHANICAL ENGINEER, age 23. Experience handling men. Will be graduated in June. Excellent grades and socially active. Interested in internal-combustion tests and steam-electric power-plant work. Me-295.

MECHANICAL ENGINEER; graduate Eastern College; 7 years' experience in metal-mining plants, industrial power plant, and machine design. Over 15 years' experience teaching mechanical engineering and college administration work. Me-296.

MECHANICAL DRAFTSMAN, 24; single; part-time drafting while attending school; desires to work toward specialized machinery design. Available June 5. Location West. Me-297-393-D-9-San Francisco.

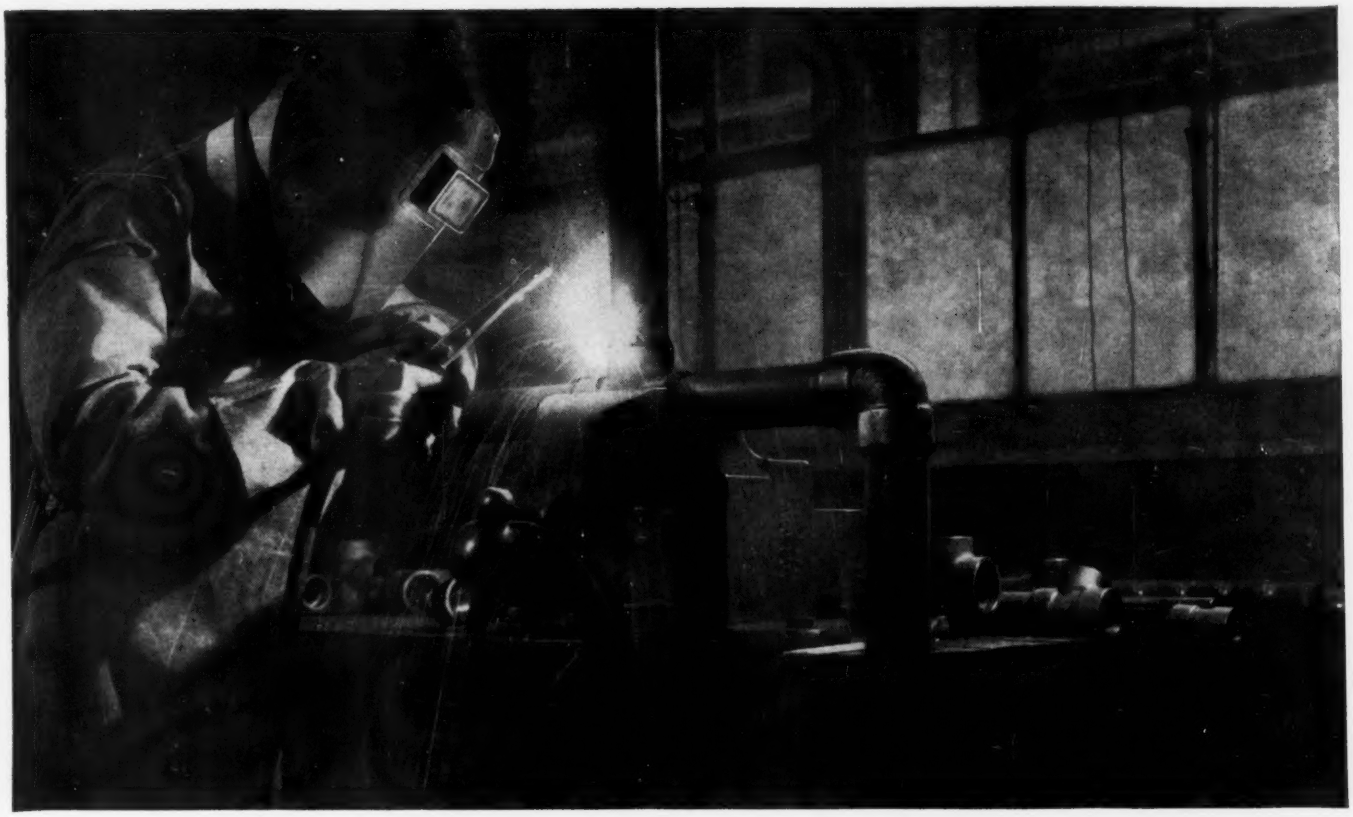
MECHANICAL ENGINEER, R.P.I., 1934, 26. Five years in large railroad-shop, roundhouse; locomotive testing, Diesel, steam, and electric. Qualified to teach Diesel or steam engines, thermodynamics, or related subjects. Me-298.

MECHANICAL GRADUATE, 27, married, three years' experience testing steam and electric power-plant equipment. Desires position as engineering assistant with future. Location, East or Middle West. Me-299.

DESIGNER-DRAFTSMAN, 28, graduate M.E., 1936. Desires position with precision or small-parts concern. Experience on large parts and electrical control. Me-300.

TEACHER OF MECHANICAL ENGINEERING, 36,

(*A.S.M.E. News continued on page 496*)



WELDED PIPE JOINTS IN LESS TIME
with CRANE'S new socket welding fittings

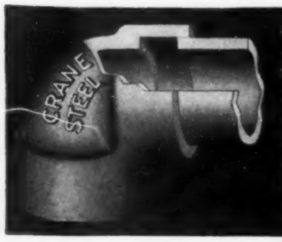
ECONOMICAL to use—because they're installed with greater ease and speed—these new Crane fittings for small lines permit wider application of welded piping. Crane Socket Welding Fittings are not made from ordinary screwed fittings blanks—they're *engineered* for welding, of forged steel—for more efficient and durable service.

The Crane design of these fittings makes socket welded joints more practical for small lines. Not only do Crane fittings eliminate pipe-end beveling and prevent the danger of welding icicles obstructing the flow, but now, pipe need not be cut to accurate length—or even square.

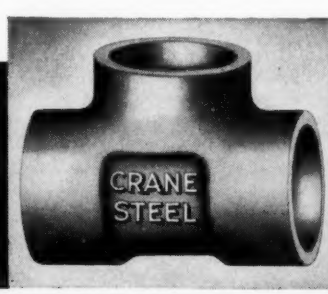
Crane design eliminates the heavy end bands that prevent uniform heat penetration in ordinary fittings. Conforming to advanced welding technique, electric arc or gas, Crane fittings provide a superior weld—with less metal, and in less time. The joint is stronger than the pipe itself.

The Crane-Quality of these fittings assures faithful performance in any application. The soundness of their design is backed by Crane's 84-year manufacturing experience in serving industry's every piping need.

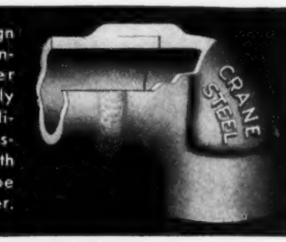
Write for Complete Information
Get all the facts on the greater efficiency and money-saving advantages of these new Crane Socket Welding Fittings. Illustrated Bulletin No. 309 gives full information on tests, sizes, ratings, prices. Mail the coupon today! No obligation.



Extra deep sockets save time—eliminate accurate pipe cutting. Liberal engagement aligns and supports pipe. Compact and light—yet strong and rugged. Only slightly larger than pipe.



Improved band design gives better heat penetration—a better weld. Run is accurately machined to inside diameter of pipe. Assures smooth flow with no pockets when pipe butts socket shoulder.



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married. Twelve years' teaching experience in heat power and design, thermodynamics, and laboratory. Ph.D. in engineering, Tau Beta Pi, and Phi Kappa Phi. Now employed. Me-301.

PROFESSOR. Eight years' experience development of apparatus for experimental engineering in fields of fluid mechanics, internal-combustion engines, steam power. Additional theory courses taught; thermodynamics, fluid mechanics, aerodynamics, dynamics of solids. Me-302.

FACTORY MANAGER OR PRODUCTION ENGINEER. Can supervise establishment proper operating sequence, design tools, design or select machinery, obtain minimum costs. Substantiate with references from four chief executives nationally known companies. Me-303.

CHIEF ENGINEER, 49, married. Successful record development of automatic machinery. Thorough factory training, quantity production. Experienced in planning and administration. Familiar with general factory management. Now employed, Middle West preferred. Me-304.

GRADUATE MECHANICAL ENGINEER desires position as maintenance or operating engineer in power or refrigeration plant. Experienced mechanic, welder, construction foreman, building maintenance; also 2 years of graduate study in refrigeration engineering. Me-305.

ENGINEER, 42. Broad experience in manufacturing, management, and merchandising. Particularly adept at organization development and training. Just completed over 6 years' rebuilding companies for financial institution. General manager or controller. Me-306.

GRADUATE MECHANICAL ENGINEER, 33. Ten years' experience in layout and development of steam turbines, gears, governors, valves, operating mechanisms, installations, and piping. New York State Engineering license. Me-307.

INSTRUCTOR, INSTRUMENT-MAKER AND DESIGNER desires summer position, college or industry. Mechanical-engineering graduate. Teaches engineering drawing, machine design, machine shop. Expert construction and design of precision instruments. Me-308.

MECHANICAL ENGINEER, recent graduate, single. Desires position, salary secondary to opportunity; 6 years' experience in salesmanship; willing to travel. Has studied aerodynamics and good at drawing. Me-309.

GRADUATE CHEMICAL AND MECHANICAL ENGINEER, 32, married. Eight years' experience in plant control; production, distribution, maintenance of steam and electricity, water purification, general mill maintenance. Available July 1, 1939. Me-310.

MECHANICAL ENGINEER, 40. Eighteen years' experience; oil refineries, chemical plants designs. Development, production of special machinery; 5 years executing government orders for military equipment. Also factory management and sales. Me-311.

MECHANICAL-METALLURGICAL ENGINEER, 26, single, Stevens graduate. Twenty months' extensive and varied training course with prominent company; 2 years broad metallurgical application. Now employed, desires connection affording opportunity for greater progress. Me-312.

REGISTERED ENGINEER, 26, A.B., M.E., Stanford, Sigma Xi, employed. Seeks position in research, design, and development. Research thesis on heat transfer. Experience, combustion, controls, oil burners, pumps, blowers, air-conditioning. Me-313.

POSITIONS AVAILABLE

DESIGNER with wide experience in design of office equipment. Must have originality and ability to carry through complete design. Only man capable of assuming full responsibility for development engineering jobs will be considered. Should have design experience with companies manufacturing adding machines, typewriters, cash registers. Salary, \$3500–\$4000 a year. Location, New England. Y-4072.

TIME-STUDY ENGINEER, 25–35, with several years' actual experience in time-study work. Rubber-shop experience preferred. Company will consider man trained in machine-shop practice. Salary, \$200–\$250 a month. Location, Middle West. Y-4123C.

FACTORY MANAGER, 32–45, graduate mechanical engineer. Should have manufacturing experience in steel stampings of all types, auto rims, wheels, and some stainless-steel production. Must have capacity to handle labor, and must be familiar with general factory management. Company prefers man with previous record of accomplishment, and ability to contact its executives. Salary, \$7000–\$10,000 a year. Location, Middle West. Y-4137C.

MECHANICAL ENGINEER, graduate of recognized technical school, not over 30. Must have creative mind and ability to design mechanical improvements. Knowledge of machine-tool operation desirable. Willing to do hard manual labor. Opportunity. Location, New Jersey. Y-4138.

INSTRUCTOR, graduate mechanical engineer with master's degree in mechanical engineering, preferably to be granted in June, 1939, with emphasis on steam power and including thesis written upon completion of comprehensive experimental work. Must have one or two years' actual practical experience in engineering industry. Teaching experience also desirable. Salary, \$1900 a year. Location, Middle West. Y-4141C.

PROFESSORS OF MECHANICAL ENGINEERING, two, ages 30–45; one to teach thermodynamics and heat power, the other to teach air conditioning, refrigeration, heating, and ventilating. Doctors' degrees are absolutely essential. Appointments will be made for September, 1939. Salary, up to \$3500 a year. Location, Middle West. Y-4150C.

SALES ENGINEER, 30–45, with experience in manufacture and application of insulation, particularly cork. Should have previous sales experience. Work will involve some drafting and layout. Considerable traveling. Salary, \$3000–\$3600 a year. Headquarters, New York, N. Y. Y-4159.

DESIGNER, graduate mechanical engineer for design of reciprocating pumps. Must have at least five years' experience in reciprocating pumping equipment, and should be familiar with design of duplex double-acting self-oiling power-driven pumps 6 to 12 in. stroke, capable of dealing with plunger loads up to 20,000 lb and for working pressures in neighborhood of 1000 lb per sq in. Location, Middle West. Y-4163C.

TOOL-AND-DIE TROUBLE MAN, 33–43, preferably graduate mechanical engineer. Must have complete knowledge of dies, be able to analyze die trouble, and give specific detailed instructions as to how to correct trouble. Company prefers man who has successfully held tryout job in reliable job-stamping company. Salary, \$250–\$300 a month. Location, Middle West. Y-4168C.

MACHINE DESIGNER, 27–45, graduate mechanical engineer, American. Duties will be drawing-board layout for design of small-size, complicated, automatic machines used in high-speed production of very small, close-tolerance, intricate metal parts. Will work from rough specifications, general data, and sketches, and suggest methods of overcoming difficulties of design which develop. Will also coordinate work of detailers and draftsmen working on his drawings. Must have 5 to 10 years' experience in engineering design problems similar to those outlined. This experience must have been acquired in industries manufacturing such products as cash registers, typewriters, or other office machines, etc., where small, intricate parts are used. Salary, up to \$300 a month. Location, East. Y-4169.

INSTRUCTOR, graduate mechanical engineer to teach engineering drawing. Master's degree highly desirable. Must have at least two years' practical experience in drafting room of high-class industrial organization; teaching experience also desirable. Apply by letter giving complete personal data, etc. Salary, \$1900 a year. Location, Middle West. Y-4171C.

MECHANICAL PLANT-BETTERMENT ENGINEER. Must have thorough acquaintance with steam-electric stations and equipment, heat-balance computations and operations and testing methods. Detailed knowledge of design methods not necessary, but very desirable that applicant have practical operating experience, preferably at utility stations. Duties include office analysis of operating results and correspondence with superintendents of power and plant; visits to individual plants, ranging in duration from one week to several months, for cooperation with field forces in improving plant economy and operating methods, and assistance in starting and testing new installations. Headquarters, New York, N. Y. Y-4173.

SALES ENGINEER with sales experience in Chicago and Midwestern territory. Mechanical and lubrication experience essential. Salary, \$200 a month plus commission. Y-4189C.

DESIGN AND DEVELOPMENT ENGINEER, 30–35, with technical college training and practical experience. Man with mechanical and electrical training and knowledge preferred. Must be able to create and design new products for company manufacturing automobile hoists. Location, East. Y-4190.

MECHANICAL ENGINEER, about 40, who has specialized in tool and die design. Should also have experience as production manager in

(*A.S.M.E. News continued on page 498*)

factory operation utilizing mass-production methods. Must have proved executive ability. Location, Middle West. Y-4195C.

ENGINEER, not over 35, with glass-container plant experience. Must be able to correlate activities of two plants and advise on application of machinery as well as the method of handling materials. Headquarters, East. Y-4197.

GRADUATE MECHANICAL ENGINEER, 27–35, to act as assistant in planning, scheduling, and budgeting experimental development and research work. Must have ability and judgment to evaluate and organize engineering-research projects. Salary, $3000–$3600 a year. Location, New York Metropolitan area. Y-4202.

MECHANICAL ENGINEER, 30–45. Duties will include checking various types of furnaces and heat-treating baths, checking plating solutions and processes, finishing processes, and some metallurgic work. Will not be involved in maintenance work, but will serve mainly as technical adviser as well as a consultant in fields mentioned. Must have good personality, tact, and diplomacy. Location, South. Y-4207.

MAINTENANCE ENGINEER, not over 40, graduate mechanical engineer with food or chemical-plant experience. Salary, $3000 a year. Location, New England. Y-4209.

INDUSTRIAL ENGINEER, 30–45, with approximately 5 years' experience in production, preferably in steel and sheet-metal plant. Some development and design experience also desirable. Salary, $3000 a year. Location, Pennsylvania. Y-4230.

ASSISTANT DESIGNER with 10 to 15 years' paper-mill or paper-box plant experience. Construction experience along these lines also desirable. Salary, $400 a month. Headquarters, New York, N. Y. Y-4233.

PLANT SUPERINTENDENT, 30–40, married, with children. Must be graduate of engineering school, preferably having specialized in mechanical, chemical, and production engineering, and must have experience in straight-line mass-production industries, preferably automobiles. Experience in woodworking industries very desirable, but not essential. Must have thorough knowledge of production cost control and ingenuity to develop ways for driving down costs. Must also have proved executive ability to assume full responsibility for plant. Must have experience in dealing with Union labor, and be able to maintain labor relations on present favorable basis. Apply by letter giving full details of experience, etc., and enclosing a small photograph. Location, Middle West. Y-4238.

MECHANICAL ENGINEER, 35–45, with wide experience. Capable eventually of taking charge of operations of business comprising melting of iron for use in casting regular foundry product of large metallurgical concern, and also for use in special castings. Must be able to cooperate with associates and have ability in handling subordinates and labor. Must also be thoroughly conversant with modern production methods, as he will be expected to coordinate in production of efficient and economical operations. Headquarters will be in New York City. Y-4239.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after June 26, 1939, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

BAKER, CLARENCE LEROY, Ft. Wayne, Ind.
BARKOW, A. G. L., Baltimore, Md.
BENTIVOGLIO, THOMAS J., East Orange, N. J.
BOLLES, SIDNEY L., Ridgewood, L. I., N. Y.
BOURKE, NORMAN T., Ft. Wayne, Ind. (Rt)
BRUENNER, ALEXANDER, Meadville, Pa.
BURCHFIELD, W. F., Kew Gardens, L. I., N. Y.
CARLSON, GORDON V., Chicago, Ill.
ESPOSITO, DANIEL J., Bridgeport, Conn.
FERGUSON, GEORGE F., New London, Conn.
GARD, EARLE W., Los Angeles, Calif. (Re)
GROMMET, CLIFFORD C., Dallas, Tex. (Re)
HAIT, J. M., Los Angeles, Calif. (Rt & T)
HATFIELD, HOMER F., Allentown, Pa.
HINCH, RALPH J., Chicago, Ill.
HOPPE, ALFRED G., Milwaukee, Wis.
HORLEBEIN, EDWIN W., Baltimore, Md.
JARRELL, G. J., Toronto, Ont., Can.
JUNG, HERBERT, New Brunswick, N. J.
MACMILLAN, K. P., Baltimore, Md. (Rt & T)
MACMILLIN, HOWARD F., Mount Gilead, Ohio
MAGEE, FREDERICK M., Arlington, Mass.
MANN, ISHAM W., JR., New Orleans, La.
MCILVAINE, R. L., Richmond, Ind.
MAYER, MALVIN J., New York, N. Y.
MONDOLFO, LUCIO, New York, N. Y.
MUNDKUR, B. S., Tatapuram, Cochin State, India
NOLAND, R. W., Ft. Wayne, Ind. (Rt)
PEARL, WILLIAM A., Chicago, Ill.
PEARSON, NILS A., Washington, D. C. (Rt)
PERKINS, N. KENNETH, Elgin, Ill.
PLANT, W. A., Smooth Rock Falls, Ont., Can.
PLUMMER, RAYMOND BENTON, Indianapolis, Ind.
RUOFF, FREDERIC L., Ft. Wayne, Ind. (Rt)
SHEARE, E. J. W., Toronto, Ont., Canada
SINCLAIR, HAROLD, London, England
SMITH, TRUMAN A., Tuscaloosa, Ala.
SYKES, E. B., Philadelphia, Pa.
TAYLOR, R. W. G., Toronto, Ont., Can.
VANIS, ALBERT A., Berwyn, Ill.
WEISS, ALEXANDER, New York, N. Y. (Rt & T)
WILLSON, T. EDGAR, Demarest, N. J. (Rt & T)

CHANGE OF GRADING

Transfer to Fellow

DEXTER, GREGORY M., Scarsdale, N. Y.

Transfers to Member

CHAPMAN, A. H., Osborne, South Australia
CLARK, C. GORDON, St. John, N. B.
EARLE, DEAN S. B., Clemson College, S. C.
GABLA, N. F., Shiraz, Iran
GRUBE, DONALD E., Alton, Ill.
HICKS, JAS. R., Waterbury, Conn.
KIMBALL, DEXTER S., JR., Binghamton, N. Y.
MASON, WENDELL E., Beverly Hills, Calif.
ODBERT, JOHN T., Lakewood, Ohio
SELVEY, A. M., Detroit, Mich.
VON BEHREN, J. NORVELL, Baltimore, Md.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

BLISS, PHILIP E., April 11, 1939
BURDSALL, ELLWOOD, March 10, 1939
CHAMBERS, CHARLES E., March 20, 1939
CLIFFORD, ERNEST L., February 8, 1939
FARRELL, JOSEPH V., March 24, 1939
HALLOCK, EDWARD F., February 23, 1939
HIRSHFELD, CLARENCE F., April 19, 1939
HUTCHINSON, CARY T., January 16, 1939
SCRANTON, DONALD H., January 6, 1939
STEVENS, LOUIS W., October 26, 1938
SWITZER, JOHN A., April 20, 1939

A.S.M.E. Transactions for May, 1939

THE May, 1939, issue of the Transactions of the A.S.M.E. contains the following papers:

Industrial Power, by C. W. E. Clarke
Organization—Design for Modern Business, by F. E. Raymond
Pulsating Air Velocity Measurement, by N. P. Bailey
The Effect of Pulsations on Orifice Meters, by S. R. Beitler
The Effect of Size and Shape of Cut Upon the Performance of Cutting Fluids When Turning S.A.E. 3140 Steel, by O. W. Boston, W. W. Gilbert, and L. V. Colwell
Thin Oil Films, by Walter Claypoole
Wear in Lubrication Problems, by L. M. Tichvinsky

DISCUSSION

On previously published papers by E. M. Cloran; D. J. Bergman; P. G. Exline; L. G. Bean; E. S. Bristol and J. C. Peters; and E. D. Haigler